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The United States Air Force High School Apprenticeship Program's (USAF- HSAP) purpose is to place outstanding high school students whose interests are in the areas of mathematics, engineering, and science to work in a laboratory environment. The students selected to participate in the program work in an Air Force Laboratory for a duration of 8 weeks during their summer vacation.

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UNITED STATES AIR FORCE

SUMMER RESEARCH PROGRAM -- 1994

HIGH SCHOOL APPRENTICESHIP PROGRAM FINAL REPORTS

VOLUME 12A

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RESEARCH & DEVELOPMENT LABORATORIES

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December 1994

PREFACE

Reports in this volume are numbered consecutively beginning with number 1. Each report is paginated with the report number followed by consecutive page numbers, e.g., 1-1, 1-2, 1-3; 2-1, 2-2, 2-3.

Due to its length, Volume 12 is bound in two parts, 12A and 12B. Volume 12A contains #1-19. Volume 12B contains reports #20-38. The Table of Contents for Volume 12 is included in both parts.

This document is one of a set of 16 volumes describing the 1994 AFOSR Summer Research Program. The following volumes comprise the set:

VOLUME	TITLE
1	Program Management Report
	Summer Faculty Research Program (SFRP) Reports
2A & 2B	Armstrong Laboratory
3A & 3B	Phillips Laboratory
4	Rome Laboratory
5A & 5B	Wright Laboratory
6	Arnold Engineering Development Center, Frank J. Seiler Research Laboratory, and Wilford Hall Medical Center
	Graduate Student Research Program (GSRP) Reports
7	Armstrong Laboratory
8	Phillips Laboratory
9	Rome Laboratory
10	Wright Laboratory
11	Arnold Engineering Development Center, Frank J. Seiler Research Laboratory, and Wilford Hall Medical Center
	High School Apprenticeship Program (HSAP) Reports
12A & 12B	Armstrong Laboratory
13	Phillips Laboratory
14	Rome Laboratory
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1. INTRODUCTION

The Summer Research Program (SRP), sponsored by the Air Force Office of Scientific Research (AFOSR), offers paid opportunities for university faculty, graduate students, and high school students to conduct research in U.S. Air Force research laboratories nationwide during the summer.

Introduced by AFOSR in 1978, this innovative program is based on the concept of teaming academic researchers with Air Force scientists in the same disciplines using laboratory facilities and equipment not often available at associates' institutions.

AFOSR also offers its research associates an opportunity, under the Summer Research Extension Program (SREP), to continue their AFOSR-sponsored research at their home institutions through the award of research grants. In 1994 the maximum amount of each grant was increased from $20,000 to $25,000, and the number of AFOSR-sponsored grants decreased from 75 to 60. A separate annual report is compiled on the SREP.

The Summer Faculty Research Program (SFRP) is open annually to approximately 150 faculty members with at least two years of teaching and/or research experience in accredited U.S. colleges, universities, or technical institutions. SFRP associates must be either U.S. citizens or permanent residents.

The Graduate Student Research Program (GSRP) is open annually to approximately 100 graduate students holding a bachelor's or a master's degree; GSRP associates must be U.S. citizens enrolled full time at an accredited institution.

The High School Apprentice Program (HSAP) annually selects about 125 high school students located within a twenty mile commuting distance of participating Air Force laboratories.

The numbers of projected summer research participants in each of the three categories are usually increased through direct sponsorship by participating laboratories.

AFOSR's SRP has well served its objectives of building critical links between Air Force research laboratories and the academic community, opening avenues of communications and forging new research relationships between Air Force and academic technical experts in areas of national interest; and strengthening the nation's efforts to sustain careers in science and engineering. The success of the SRP can be gauged from its growth from inception (see Table 1) and from the favorable responses the 1994 participants expressed in end-of-tour SRP evaluations (Appendix B).

AFOSR contracts for administration of the SRP by civilian contractors. The contract was first awarded to Research & Development Laboratories (RDL) in September 1990. After completion of the 1990 contract, RDL won the recompetition for the basic year and four 1-year options.

2. PARTICIPATION IN THE SUMMER RESEARCH PROGRAM

The SRP began with faculty associates in 1979; graduate students were added in 1982 and high school students in 1986. The following table shows the number of associates in the program each year.

Table 1: SRP Participation, by Year

YEAR	Number of Participants			TOTAL
	SFRP	GSRP	HSAP	
1979	70			70
1980	87			87
1981	87			87
1982	91	17		108
1983	101	53		154
1984	152	84		236
1985	154	92		246
1986	158	100	42	300
1987	159	101	73	333
1988	153	107	101	361
1989	168	102	103	373
1990	165	121	132	418
1991	170	142	132	444
1992	185	121	159	464
1993	187	117	136	440
1994	192	117	133	442

Beginning in 1993, due to budget cuts, some of the laboratories weren't able to afford to fund as many associates as in previous years; in one case a laboratory did not fund <u>any</u> additional associates. However, the table shows that, overall, the number of participating associates increased this year because two laboratories funded more associates than they had in previous years.

3. RECRUITING AND SELECTION

The SRP is conducted on a nationally advertised and competitive-selection basis. The advertising for faculty and graduate students consisted primarily of the mailing of 8,000 44-page SRP brochures to chairpersons of departments relevant to AFOSR research and to administrators of grants in accredited universities, colleges, and technical institutions. Historically Black Colleges and Universities (HBCUs) and Minority Institutions (MIs) were included. Brochures also went to all participating USAF laboratories, the previous year's participants, and numerous (over 600 annually) individual requesters.

Due to a delay in awarding the new contract, RDL was not able to place advertisements in any of the following publications in which the SRP is normally advertised: *Black Issues in Higher Education, Chemical & Engineering News, IEEE Spectrum* and *Physics Today.*

High school applicants can participate only in laboratories located no more than 20 miles from their residence. Tailored brochures on the HSAP were sent to the head counselors of 180 high schools in the vicinity of participating laboratories, with instructions for publicizing the program in their schools. High school students selected to serve at Wright Laboratory's Armament Directorate (Eglin Air Force Base, Florida) serve eleven weeks as opposed to the eight weeks normally worked by high school students at all other participating laboratories.

Each SFRP or GSRP applicant is given a first, second, and third choice of laboratory. High school students who have more than one laboratory or directorate near their homes are also given first, second, and third choices.

Laboratories make their selections and prioritize their nominees. AFOSR then determines the number to be funded at each laboratory and approves laboratories' selections.

Subsequently, laboratories use their own funds to sponsor additional candidates. Some selectees do not accept the appointment, so alternate candidates are chosen. This multi-step selection procedure results in some candidates being notified of their acceptance after scheduled deadlines. The total applicants and participants for 1994 are shown in this table.

Table 2: 1994 Applicants and Participants

PARTICIPANT CATEGORY	TOTAL APPLICANTS	SELECTEES	DECLINING SELECTEES
SFRP (HBCU/MI)	600 (90)	192 (16)	30 (7)
GSRP (HBCU/MI)	322 (11)	117 (6)	11 (0)
HSAP	562	133	14
TOTAL	1484	442	55

4. SITE VISITS

During June and July of 1994, representatives of both AFOSR/NI and RDL visited each participating laboratory to provide briefings, answer questions, and resolve problems for both laboratory personnel and participants. The objective was to ensure that the SRP would be as constructive as possible for all participants. Both SRP participants and RDL representatives found these visits beneficial. At many of the laboratories, this was the only opportunity for all participants to meet at one time to share their experiences and exchange ideas.

5. HISTORICALLY BLACK COLLEGES AND UNIVERSITIES AND MINORITY INSTITUTIONS (HBCU/MIs)

In previous years, an RDL program representative visited from seven to ten different HBCU/MIs to promote interest in the SRP among the faculty and graduate students. Due to the late contract award date (January 1994) no time was available to visit HBCU/MIs this past year.

In addition to RDL's special recruiting efforts, AFOSR attempts each year to obtain additional funding or use leftover funding from cancellations the past year to fund HBCU/MI associates. This year, seven HBCU/MI SFRPs declined after they were selected. The following table records HBCU/MI participation in this program.

Table 3: SRP HBCU/MI Participation, by Year

YEAR	SFRP		GSRP	
	Applicants	Participants	Applicants	Participants
1985	76	23	15	11
1986	70	18	20	10
1987	82	32	32	10
1988	53	17	23	14
1989	39	15	13	4
1990	43	14	17	3
1991	42	13	8	5
1992	70	13	9	5
1993	60	13	6	2
1994	90	16	11	6

6. SRP FUNDING SOURCES

Funding sources for the 1994 SRP were the AFOSR-provided slots for the basic contract and laboratory funds. Funding sources by category for the 1994 SRP selected participants are shown here.

Table 4: 1994 SRP Associate Funding

FUNDING CATEGORY	SFRP	GSRP	HSAP
AFOSR Basic Allocation Funds	150	98*1	121*2
USAF Laboratory Funds	37	19	12
HBCU/MI By AFOSR (Using Procured Addn'l Funds)	5	0	0
TOTAL	192	117	133

*1 - 100 were selected, but two canceled too late to be replaced.
*2 - 125 were selected, but four canceled too late to be replaced.

7. COMPENSATION FOR PARTICIPANTS

Compensation for SRP participants, per five-day work week, is shown in this table.

Table 5: 1994 SRP Associate Compensation

PARTICIPANT CATEGORY	1991	1992	1993	1994
Faculty Members	$690	$718	$740	$740
Graduate Student (Master's Degree)	$425	$442	$455	$455
Graduate Student (Bachelor's Degree)	$365	$380	$391	$391
High School Student (First Year)	$200	$200	$200	$200
High School Student (Subsequent Years)	$240	$240	$240	$240

The program also offered associates whose homes were more than 50 miles from the laboratory an expense allowance (seven days per week) of $50/day for faculty and $37/day for graduate students.

Transportation to the laboratory at the beginning of their tour and back to their home destinations at the end was also reimbursed for these participants. Of the combined SFRP and GSRP associates, 58% (178 out of 309) claimed travel reimbursements at an average round-trip cost of $860.

Faculty members were encouraged to visit their laboratories before their summer tour began. All costs of these orientation visits were reimbursed. Forty-one percent (78 out of 192) of faculty associates took orientation trips at an average cost of $498. Many faculty associates noted on their evaluation forms that due to the late notice of acceptance into the 1994 SRP (caused by the late award in January 1994 of the contract) there wasn't enough time to attend an orientation visit prior to their tour start date. In 1993, 58 % of SFRP associates took orientation visits at an average cost of $685.

Program participants submitted biweekly vouchers countersigned by their laboratory research focal point, and RDL issued paychecks so as to arrive in associates' hands two weeks later.

HSAP program participants were considered actual RDL employees, and their respective state and federal income tax and Social Security were withheld from their paychecks. By the nature of their independent research, SFRP and GSRP program participants were considered to be consultants or independent contractors. As such, SFRP and GSRP associates were responsible for their own income taxes, Social Security, and insurance.

8. CONTENTS OF THE 1994 REPORT

The complete set of reports for the 1994 SRP includes this program management report augmented by fifteen volumes of final research reports by the 1994 associates as indicated below:

Table 6: 1994 SRP Final Report Volume Assignments

	VOLUME		
LABORATORY	SFRP	GSRP	HSAP
Armstrong	2	7	12
Phillips	3	8	13
Rome	4	9	14
Wright	5A, 5B	10	15
AEDC, FJSRL, WHMC	6	11	16

AEDC = Arnold Engineering Development Center
FJSRL = Frank J. Seiler Research Laboratory
WHMC = Wilford Hall Medical Center

APPENDIX A -- PROGRAM STATISTICAL SUMMARY

A. Colleges/Universities Represented

Selected SFRP and GSRP associates represent 158 different colleges, universities, and institutions.

B. States Represented

SFRP -Applicants came from 46 states plus Washington D.C. and Puerto Rico. Selectees represent 40 states.

GSRP - Applicants came from 46 states and Puerto Rico. Selectees represent 34 states.

HSAP - Applicants came from fifteen states. Selectees represent ten states.

C. Academic Disciplines Represented

The academic disciplines of the combined 192 SFRP associates are as follows:

Electrical Engineering	22.4%
Mechanical Engineering	14.0%
Physics: General, Nuclear & Plasma	12.2%
Chemistry & Chemical Engineering	11.2%
Mathematics & Statistics	8.1%
Psychology	7.0%
Computer Science	6.4%
Aerospace & Aeronautical Engineering	4.8%
Engineering Science	2.7%
Biology & Inorganic Chemistry	2.2%
Physics: Electro-Optics & Photonics	2.2%
Communication	1.6%
Industrial & Civil Engineering	1.6%
Physiology	1.1%
Polymer Science	1.1%
Education	0.5%
Pharmaceutics	0.5%
Veterinary Medicine	0.5%
TOTAL	100%

Table A-1. Total Participants

Number of Participants	
SFRP	192
GSRP	117
HSAP	133
TOTAL	442

Table A-2. Degrees Represented

Degrees Represented			
	SFRP	GSRP	TOTAL
Doctoral	189	0	189
Master's	3	47	50
Bachelor's	0	70	70
TOTAL	192	117	309

Table A-3. SFRP Academic Titles

Academic Titles	
Assistant Professor	74
Associate Professor	63
Professor	44
Instructor	5
Chairman	1
Visiting Professor	1
Visiting Assoc. Prof.	1
Research Associate	3
TOTAL	192

Table A-4. Source of Learning About SRP

SOURCE	SFRP		GSRP	
	Applicants	Selectees	Applicants	Selectees
Applied/participated in prior years	26%	37%	10%	13%
Colleague familiar with SRP	19%	17%	12%	12%
Brochure mailed to institution	32%	18%	19%	12%
Contact with Air Force laboratory	15%	24%	9%	12%
Faculty Advisor (GSRPs Only)	--	--	39%	43%
Other source	8%	4%	11%	8%
TOTAL	100%	100%	100%	100%

Table A-5. Ethnic Background of Applicants and Selectees

	SFRP		GSRP		HSAP	
	Applicants	Selectees	Applicants	Selectees	Applicants	Selectees
American Indian or Native Alaskan	0.2%	0%	1%	0%	0.4%	0%
Asian/Pacific Islander	30%	20%	6%	8%	7%	10%
Black	4%	1.5%	3%	3%	7%	2%
Hispanic	3%	1.9%	4%	4.5%	11%	8%
Caucasian	51%	63%	77%	77%	70%	75%
Preferred not to answer	12%	14%	9%	7%	4%	5%
TOTAL	100%	100%	100%	100%	99%	100%

Table A-6. Percentages of Selectees receiving their 1st, 2nd, or 3rd Choices of Directorate

	1st Choice	2nd Choice	3rd Choice	Other Than Their Choice
SFRP	70%	7%	3%	20%
GSRP	76%	2%	2%	20%

APPENDIX B -- SRP EVALUATION RESPONSES

1. OVERVIEW

Evaluations were completed and returned to RDL by four groups at the completion of the SRP. The number of respondents in each group is shown below.

Table B-1. Total SRP Evaluations Received

Evaluation Group	Responses
SFRP & GSRPs	275
HSAPs	116
USAF Laboratory Focal Points	109
USAF Laboratory HSAP Mentors	54

All groups indicate near-unanimous enthusiasm for the SRP experience.

Typical comments from 1994 SRP associates are:

> "[The SRP was an] excellent opportunity to work in state-of-the-art facility with top-notch people."

> "[The SRP experience] enabled exposure to interesting scientific application problems; enhancement of knowledge and insight into 'real-world' problems."

> "[The SRP] was a great opportunity for resourceful and independent faculty [members] from small colleges to obtain research credentials."

> "The laboratory personnel I worked with are tremendous, both personally and scientifically. I cannot emphasize how wonderful they are."

> "The one-on-one relationship with my mentor and the hands on research experience improved [my] understanding of physics in addition to improving my library research skills. Very valuable for [both] college and career!"

Typical comments from laboratory focal points and mentors are:

> "This program [AFOSR - SFRP] has been a 'God Send' for us. Ties established with summer faculty have proven invaluable."
>
> "Program was excellent from our perspective. So much was accomplished that new options became viable "
>
> "This program managed to get around most of the red tape and 'BS' associated with most Air Force programs. Good Job!"
>
> "Great program for high school students to be introduced to the research environment. Highly educational for others [at laboratory]."
>
> "This is an excellent program to introduce students to technology and give them a feel for [science/engineering] career fields. I view any return benefit to the government to be 'icing on the cake' and have usually benefitted."

The summarized recommendations for program improvement from both associates and laboratory personnel are listed below (Note: basically the same as in previous years.)

A. Better preparation on the labs' part prior to associates' arrival (i.e., office space, computer assets, clearly defined scope of work).

B. Laboratory sponsor seminar presentations of work conducted by associates, and/or organized social functions for associates to collectively meet and share SRP experiences.

C. Laboratory focal points collectively suggest more AFOSR allocated associate positions, so that more people may share in the experience.

D. Associates collectively suggest higher stipends for SRP associates.

E. Both HSAP Air Force laboratory mentors and associates would like the summer tour extended from the current 8 weeks to either 10 or 11 weeks; the groups state it takes 4-6 weeks just to get high school students up-to-speed on what's going on at laboratory. (Note: this same arguement was used to raise the faculty and graduate student participation time a few years ago.)

2. 1994 USAF LABORATORY FOCAL POINT (LFP) EVALUATION RESPONSES

The summarized results listed below are from the 109 LFP evaluations received.

1. LFP evaluations received and associate preferences:

Table B-2. Air Force LFP Evaluation Responses (By Type)

		How Many Associates Would You Prefer To Get ?								(% Response)			
		SFRP				GSRP (w/Univ Professor)				GSRP (w/o Univ Professor)			
Lab	Evals Recv'd	0	1	2	3+	0	1	2	3+	0	1	2	3+
AEDC	10	30	50	0	20	50	40	0	10	40	60	0	0
AL	44	34	50	6	9	54	34	12	0	56	31	12	0
FJSRL	3	33	33	33	0	67	33	0	0	33	67	0	0
PL	14	28	43	28	0	57	21	21	0	71	28	0	0
RL	3	33	67	0	0	67	0	33	0	100	0	0	0
WHMC	1	0	0	100	0	0	100	0	0	0	100	0	0
WL	46	15	61	24	0	56	30	13	0	76	17	6	0
Total	121	25%	43%	27%	4%	50%	37%	11%	1%	54%	43%	3%	0%

LFP Evaluation Summary. The summarized repsonses, by laboratory, are listed on the following page. LFPs were asked to rate the following questions on a scale from 1 (below average) to 5 (above average).

2. LFPs involved in SRP associate application evaluation process:
   a. Time available for evaluation of applications:
   b. Adequacy of applications for selection process:
3. Value of orientation trips:
4. Length of research tour:
5 a. Benefits of associate's work to laboratory:
   b. Benefits of associate's work to Air Force:
6. a. Enhancement of research qualifications for LFP and staff:
   b. Enhancement of research qualifications for SFRP associate:
   c. Enhancement of research qualifications for GSRP associate:
7. a. Enhancement of knowledge for LFP and staff:
   b. Enhancement of knowledge for SFRP associate:
   c. Enhancement of knowledge for GSRP associate:
8. Value of Air Force and university links:
9. Potential for future collaboration:
10. a. Your working relationship with SFRP:
    b. Your working relationship with GSRP:
11. Expenditure of your time worthwhile:

(Continued on next page)

12. Quality of program literature for associate:
13. a. Quality of RDL's communications with you:
    b. Quality of RDL's communications with associates:
14. Overall assessment of SRP:

Laboratory Focal Point Reponses to above questions

	AEDC	*AL*	*FJSRL*	*PL*	*RL*	*WHMC*	*WL*
# Evals Recv'd	10	32	3	14	3	1	46
Question #							
2	90 %	62 %	100 %	64 %	100 %	100 %	83 %
2a	**3.5**	**3.5**	4.7	4.4	4.0	4.0	**3.7**
2b	4.0	3.8	4.0	4.3	4.3	4.0	3.9
3	4.2	3.6	4.3	3.8	4.7	4.0	4.0
4	3.8	3.9	4.0	4.2	4.3	NO ENTRY	4.0
5a	4.1	4.4	4.7	4.9	4.3	3.0	4.6
5b	4.0	4.2	4.7	4.7	4.3	3.0	4.5
6a	**3.6**	4.1	**3.7**	4.5	4.3	**3.0**	4.1
6b	3.6	4.0	4.0	4.4	4.7	3.0	4.2
6c	3.3	4.2	4.0	4.5	4.5	3.0	4.2
7a	3.9	4.3	4.0	4.6	4.0	3.0	4.2
7b	4.1	4.3	4.3	4.6	4.7	3.0	4.3
7c	3.3	4.1	4.5	4.5	4.5	5.0	4.3
8	4.2	4.3	5.0	4.9	4.3	5.0	4.7
9	3.8	4.1	4.7	5.0	4.7	5.0	4.6
10a	4.6	4.5	5.0	4.9	4.7	5.0	4.7
10b	4.3	4.2	5.0	4.3	5.0	5.0	4.5
11	4.1	4.5	4.3	4.9	4.7	4.0	4.4
12	4.1	3.9	4.0	4.4	4.7	3.0	4.1
13a	**3.8**	**2.9**	4.0	4.0	4.7	**3.0**	**3.6**
13b	**3.8**	**2.9**	4.0	4.3	4.7	**3.0**	**3.8**
14	4.5	4.4	5.0	4.9	4.7	4.0	4.5

3. 1994 SFRP & GSRP EVALUATION RESPONSES

The summarized results listed below are from the 275 SFRP/GSRP evaluations received.

Associates were asked to rate the following questions on a scale from
1 (below average) to 5 (above average)

1. The match between the laboratories research and your field:		4.6
2. Your working relationship with your LFP:		4.8
3. Enhancement of your academic qualifications:		4.4
4. Enhancement of your research qualifications:		4.5
5. Lab readiness for you: LFP, task, plan:		4.3
6. Lab readiness for you: equipment, supplies, facilities:		4.1
7. Lab resources:		4.3
8. Lab research and administrative support:		4.5
9. Adequacy of brochure and associate handbook:		4.3
10. RDL communications with you:		4.3
11. Overall payment procedures:		**3.8**
12. Overall assessment of the SRP:		4.7
13. a. Would you apply again?	Yes:	85%
b. Will you continue this or related research?	Yes:	95%
14. Was length of your tour satisfactory?	Yes:	86%
15. Percentage of associates who engaged in:		
a. Seminar presentation:		52%
b. Technical meetings:		32%
c. Social functions:		03%
d. Other		01%

16. Percentage of associates who experienced difficulties in:

a. Finding housing:	12%
b. Check Cashing:	03%

17. Where did you stay during your SRP tour?

a. At Home:	20%
b. With Friend:	06%
c. On Local Economy:	47%
d. Base Quarters:	10%

THIS SECTION FACULTY ONLY:

18. Were graduate students working with you? Yes: 23%

19. Would you bring graduate students next year? Yes: 56%

20. Value of orientation visit:

Essential:	29%
Convenient:	20%
Not Worth Cost:	01%
Not Used:	34%

THIS SECTION GRADUATE STUDENTS ONLY:

21. Who did you work with:

University Professor:	18%
Laboratory Scientist:	54%

4. 1994 USAF LABORATORY HSAP MENTOR EVALUATION RESPONSES

The summarized results listed below are from the 54 mentor evaluations received.

1. Mentor apprentice preferences:

Table B-3. Air Force Mentor Responses

		How Many Apprentices Would You Prefer To Get ?			
		HSAP Apprentices Preferred			
Laboratory	***# Evals Recv'd***	***0***	**1**	**2**	**3+**
AEDC	6	0	100	0	0
AL	17	29	47	6	18
PL	9	22	78	0	0
RL	4	25	75	0	0
WL	18	22	55	17	6
Total	**54**	**20%**	**71%**	**5%**	**5%**

Mentors were asked to rate the following questions on a scale from 1 (below average) to 5 (above average)

2. Mentors involved in SRP apprentice application evaluation process:
   a. Time available for evaluation of applications:
   b. Adequacy of applications for selection process:
3. Laboratory's preparation for apprentice:
4. Mentor's preparation for apprentice:
5. Length of research tour:
6. Benefits of apprentice's work to U.S. Air force:
7. Enhancement of academic qualifications for apprentice:
8. Enhancement of research skills for apprentice:
9. Value of U.S. Air Force/high school links:
10. Mentor's working relationship with apprentice:
11. Expenditure of mentor's time worthwhile:
12. Quality of program literature for apprentice:
13. a. Quality of RDL's communications with mentors:
    b. Quality of RDL's communication with apprentices:
14. Overall assessment of SRP:

	AEDC	*AL*	*PL*	*RL*	*WL*
# Evals Recv'd	**6**	**17**	**9**	**4**	**18**
Question #					
2	100 %	76 %	56 %	75 %	61 %
2a	4.2	4.0	**3.1**	**3.7**	**3.5**
2b	4.0	4.5	4.0	4.0	3.8
3	4.3	**3.8**	**3.9**	**3.8**	**3.8**
4	4.5	**3.7**	**3.4**	4.2	**3.9**
5	**3.5**	4.1	**3.1**	**3.7**	**3.6**
6	4.3	3.9	4.0	4.0	4.2
7	4.0	4.4	4.3	4.2	3.9
8	4.7	4.4	4.4	4.2	4.0
9	4.7	4.2	3.7	4.5	4.0
10	4.7	4.5	4.4	4.5	4.2
11	4.8	4.3	4.0	4.5	4.1
12	4.2	4.1	4.1	4.8	3.4
13a	**3.5**	**3.9**	**3.7**	4.0	**3.1**
13b	4.0	4.1	3.4	4.0	3.5
14	4.3	4.5	3.8	4.5	4.1

5. 1994 HSAP EVALUATION RESPONSES

The summarized results listed below are from the 116 HSAP evaluations received.

HSAP apprentices were asked to rate the following questions on a scale from 1 (below average) to 5 (above average)

1. Match of lab research to you interest:		3.9
2. Apprentices working relationship with their mentor and other lab scientists:		4.6
3. Enhancement of your academic qualifications:		4.4
4. Enhancement of your research qualifications:		4.1
5. Lab readiness for you: mentor, task, work plan		**3.7**
6. Lab readiness for you: equipment supplies facilities		4.3
7. Lab resources: availability		4.3
8. Lab research and administrative support:		4.4
9. Adequacy of RDL's apprentice handbook and administrative materials:		4.0
10. Responsiveness of RDL's communications:		**3.5**
11. Overall payment procedures:		**3.3**
12. Overall assessment of SRP value to you:		4.5
13. Would you apply again next year?	Yes:	88%
14. Was length of SRP tour satisfactory?	Yes:	78%
15. Percentages of apprentices who engaged in:		
a. Seminar presentation:		48%
b. Technical meetings:		23%
c. Social functions:		18%

REINVENTORY OF THE TECHNICAL INFORMATION OF TYNDALL AFB AND BANYAN INSTALLATION IN THE PENTAGON

Eugenia D. Baker

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Lynn Haven, FL 32444

Final Report for:
High School Apprentice Program
Armstrong Laboraotory

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, DC

and

Armstrong Laboratory

August 1994

REINVENTORY OF THE TECHNICAL INFORMATION

CENTER OF TYNDALL AFB AND

BANYAN INSTALLATION IN THE PENTAGON

Eugenia D. Baker

Summer Apprentice

Department of Defense

Tyndall Air Force Base, FL

Abstract

During the course of eight weeks this summer I was placed in two separate directorates; in the TIC, refferred to as the Technical Information Center, where I helped with inventory of the some 12,000 books there, and SC, refferred to as the agencys head computer directorate. I would say that both of these directories are a basis towards the agencys functioning as a whole, and I learned a great deal while working in both. Another major attribute towards working along with the computer experts in SC was that I learned the complete installation process of the Banyan system and actually had a chance to practice my newly accquirred knowledge by accompanying the directorate on a one week TDY trip to the Pentagon and installing the system in some 160 PC's in "Civil engineering Country." I believe that this was an exceptionally good and enlightening experience tfor me in that I became able to assume an overall better generalized assessment of the 'working field' and make a knowledgably better decision about what I would like my future to hold. I will also count it as an experience I will never forget.

REINVENTORY OF THE TECHNICAL INFORMATION

CENTER OF TYNDALL AFB AND

BANYAN INSTALLATION IN THE PENTAGON

Eugenia D. Baker

When I first got in touch with my mentor, Ms.Mary Reynolds, I was informed that I would be working for the TIC, the Technical Information Center at AFCESA, the Air Force Civil Engineering Support Agency. During this time I worked towards inventorying the total civil and environmental engineering book collection of some 12,000 books plus magazines, newspapers, documents,etc. This unique set of information is also of value as a 'transferable technology" to the worldwide scientific and engineering community, and to practicing environmental technologists everywhere.

The TechLib Plus Migration Preparation Checklist written by Mr. Andrew Poulis used as a guideline for the inventory is as follows:

1. Weed. Migraton/conversion from one system to another is a very expensive and painful process. Separate obsolete material.

2. Organize the TIC shelves in strict shelf list (LC#, AD#, ADF#, PB#, N#, DE#, L#, Serials Alpha Sequence) order.

3. Do a thorough physical inventory, making sure that each of the items to be converted is physically on the shelves or checked out. Items which are not need to be deleted from the database or replaced. If it is only a copy which no longer exists, clearly line-out the reference to that copy on the TechLib record.

4. Create a cataloging record for items which do not have one. If the item has an LC card number (two digits,hyphen,several more digits) and/or ISBN (ten digits) it is very inmportant/useful to include them. Each TechLib record should have basic bibliographic information. Editions/dates need to

match. Multiple copies/years/volumes need to be included since all separate physical items in our collection need to be barcoded separately.

5. Edit the call number. Any fields, such as author, title, corporate authors, descriptors, subjects etc. on the TechLib that need to be changed need to follow our already established procedures. For example, acquisition date, routing symbol, purchase order number, price, mode of order, order source, funding, etc, will have to be there. These fields are very important for delivering statistical reports to the division chief when budget questions arise.

This continued for the first couple of weeks, after which I began working for SC, the computer directorate of AFCESA the second half of the day. For the next five weeks I continued the inventory of the TIC in the morning and learned the complete installation process of the Banyan network by working in SC in the afternoon along with two other high school companions. By about the fourth week of becoming very familiar with the program, we began to practice installing the network in the computers around the agency that had yet to be done. We thus became so familiar in installing the system that the colonel of SC asked us to go with him and select people in the directorate on their TDY trip scheduled for our last work week to install the Banyan system in the some 160 PC's in the civil engineering part of the Pentagon. We excitedly and anticipatingly accepted the opportunity and at once began to work exceedingly hard at perfecting our knowledge and learning every extra bit of information possible to help us better understand every aspect of the process as a whole, in addition to the individual programs included in the system.

On July 29,1994 we were called together for one last meeting before our final departure to Washington on July 31. At this meeting we found out the unlucky fact that in addition to simply installing Banyan, the engineers also wanted us to install single lightspeed on each PC instead of using the single server. This meant learning something completely new. Not to mention that this news came at the last possible moment that it could have. This I learned was the way the world works. But through extensive eand fast-paced hours of study and concentration we were no doubt able to pull through the situation in high hopes that the outcome would be a good one as long as we all worked together and gave it every effort we had.

On July 31 we pulled out of the Panama City Airport with these high hopes, and on August 5, left the Pentagon with the wonderful feeling of triumph. Another exciting thing that occurred during the midst of all of this combined work and excitement was getting to meet General McCarthy who presented each of us with a civil engineer medal and also took a picture with each of us, which will appear in two magazines. Needless to say this was not only a summer I will never forget, but an experience of a lifetime. I will treasure always.

I would hence like to thank the people at RDL and everyone else involved for making this opportunity an exciting experience, and I would greatly appreciate working for you again in the near future.

In order for you to better understand what was involved in the installation of the Banyan system I am enclosing the Installation Guideline along with the instructions for installing the single lightspeed. Also, following the Guideline is a letter of appreciation from Lt. Col Smitherman of the TIC which I am proud to show you. Thank you, once again for the opportunity to work at Tyndall AFB FL.

Server = Pent-AFCE001

INSTALLATION GUIDELINE

Run MSD

Examine Memory

Calculate memory settings and annotate

-- It may be necessary to move the WLOC card in order to optimize memory and minimize fragmentation (Wang = E000-EFFF, GTSI = D000-DFFF)

IMPORTANT: Place card as low as possible in memory so it doesn't become fragmented.

RULE OF THUMB: GTSI -- usually uses C000-C3FF

Wang -- usually uses C800-CBFF

From the ROOT of *drive:* create three directories:

md vines

md ls

COPY the contents of the VINES directory on disk to the \VINES directory on *drive:*

Configure Network Interface Card (NIC) according to memory configuration

Examine **CONFIG.SYS** and **AUTOEXEC.BAT** for any unusual drivers, statements, etc.

NOTE: If you are unfamiliar with anything **DO NOT** rename these files, make only the necessary modifications. Continue with the next section. It may be advisable to copy the existing config and autoexec files to a boot disk, in case there are any problems upon reboot.

REName **CONFIG.SYS** and **AUTOEXEC.BAT**

to **CONFIG.ORG** and **AUTOEXEC.ORG**

Determine DOS Version (i.e., type **VER** at DOS prompt)

Select configuration required for user and copy appropriate configuration files from configuration diskette

REName files copied from configuration diskette to **CONFIG.SYS** and **AUTOEXEC.BAT**

Change to the \VINES on *drive:* and run PCCONFIG.EXE

(*drive:*\VINES>pcconfig)

Set Network Card Settings -- Configure NIC memory, I/O Base and IRQ according to jumpers or software settings

Login Environment Settings:

Default Communications Driver -- Select the appropriate NIC

Edit Login Group Search List -- standards:

1. *group@organization* group @ Pent-AFCE
mis @Pent-AFCE
2. **MIS**@*organization* PENT-AFCE001 @ servers
3. *servername*@**Servers**

Set Maximum Number of File Volumes = 10

Edit the **config.sys** file and adjust memory and other settings to match hardware requirements

NOTE: Use "I=E000-EFFF" instead of "M9".

Edit the **autoexec.bat** file and adjust settings to match hardware/software requirements and disable the statement that begins Windows

REBOOT

Log in to the Banyan Server with an administrative logon

Change to the \WINDOWS directory on *drive*: and run SETUP

Select the most recent Banyan VINES driver available (ignore any warnings of incompatibility problems)

When prompted for a diskette containing the drivers enter the location of the administrative setup and press ENTER

Edit the **progman.ini** file and manually add the VINES.GRP, VINESOFF.GRP and VINESNET.GRP

GTS1 - ~~7013~~ 8216 config.d5 - DEVICEHIGH=c:\VINES\PROTMAN.DOS/
config.d6 DEVICEHIGH = C:\VINES\SMC8000.OC
C:\VINES

Edit the windows**system.ini** file

NOTE: The EMMExclude and EMMInclude statements should match the config.sys

Change to the \LS directory on *drive*: and run VCONFIG.EXE

Format standard is "group_serial #_last name"

Change to the \WINDOWS directory on *drive*: and run windows

Install the VINES drivers

VERY IMPORTANT: Make sure the BANYAN Vines Network is installed in Windows -- this could cause a problem with Beyond Mail.

Run LSCONFIG (Y:\LS\WINDOWS\LSCONFIG)

Run VSTW to check connection to WANG VS

Select and Save fonts

Add printers to control panel and set default printer

Save changes

Exit windows

Fine tune system memory

If you had previously REMed windows from the autoexec.bat, remember to enable the statement once again.

SMC INSTALLATION (8216)

1. Check memory on PC.
   Run MSD (from C prompt)
   Press "M"
      ** Prefer card 's memory address be set as low as possible.
2. Set Config.sys.
   Type "Edit config.sys"
   Make appropriate modifications
3. Shutdown PC.
4. Install SMC card in available slot.
   Make sure the jumper is set for soft configuration.
5. Start PC.
   ** Make sure DOS is run outside of WINDOWS.
6. Insert the SMC software disk.
7. Change to appropriate drive and run EZSTART.
   Type "EZSTART" (ex. - B:\>ezstart)
   Click "Manual Setup"
8. Manual setup of the SMC software.
   W1 Jumper - Adapter Setup: SOFT
      I/O Base: 300
      IRQ: 5
      RAM Base: (relative to each PC's memory config.)
      Enable ROM: (No -- box should be blank)
      ROM Base: take default
      ROM Size: take default
   Network Interface: 10BASE-T or BNC
9. Save SMC setup.
   Click "Save"
10. Exit SMC setup.
11. Reboot PC to insure there are no conflicts with the new card and configuration.

PC'S W/WLOC CARDS

INSTRUCTIONS FOR INSTALLING LIGHTSPEED (LS)

1. Copy all the Light Speed files to a directory call LS

2. Find Serial Number of PC, and write it down. Also find out if and how many printers the PC is directly connected (physically cabled) to.

3. Run Windows, then DoubleClick on WINLOC
   a. Click on SESSION
   b. Click on SETTING
   c. Click on OPTIONS
   d. Write down System Settings for:
      Memory Map (ie D000) and
      IO Base Address (ie 0342)
   e. Click on CANCEL
   f. Click on SESSION
   g. Click TERMINATE
   h. Find the Control Panel and DoubleClick on it
   i. DoubleClick on Printers
   j. Make sure there is NOT! an X in the box that says Use Print Manager. If there is take it out.
   k. Close Printers, then Close Control Panel
   l. Get out of WINDOWS

4. Configure the PC by (see Configure the PC page 4)
   a. cd c:\LS
   b. Run VCONFIG by typing 'VCONFIG' at the DOS prompt
   c. PC Name will be three ltr office symbol (ie DXD) followed by a space, followed by serial number of PC (Step 1), followed by a space, followed by person who uses the PC's last name.
   d. 928 address is the memory map found in Step 2d
   e. 928 Port Address is the IO address found in Step 2d
   f. Press PF Key 10 to EXIT

5. Edit C:\CONFIG.SYS
   a. REMark out the line for LNKMNGR.
      ~~(IE: REM~~ device=C:\PCLIS\LNKMNGR.EXE)
   b. write down the drive letter given on the LASTDRIVE statement. - H.
      If there is no LASTDRIVE statement in the CONFIG.SYS file, then add LASTDRIVE=K
   c. Save and EXIT

6. Edit C:\AUTOEXEC.BAT and ~~REM out PCLIS Commands or the CALL to NETLINK.BAT.~~

   a. put c:\LS on the end of your path statement

   b. Type (add) the following new line at end of all the SET statements. In the lines below you will substitute the appropraite values on the lines with parenthesies--

   SET LS=C:\LS
   CD c:\LS
   SINGLE
   VATTACH /V=(Ltr of LASTDRIVE in config.sys, dont put the colon)
   REM VSMAP (Ltr of LASTDRIVE in config.sys) d:\DOS1

   c. Continue adding the lines below, however IF the PC is not physically cabled to a printer you should put two VSPOOL statements. The first will have LOCAL=1, for LPT1, and the second will have LOCAL=2, for LPT2. Put the number of the printer that ypu want to connect to on the VS for (Printer No.) as desired for LPT1 AND/OR LPT2. The (Print Class) is the VS Print Class that is assigned to that Printer No. Your Secretary generally knows the printer numbers and print classes, or at least knows how to find out. Examples of this command are given on PC to VS Printing pages 1 and 2.

   VSPOOL PRINTER=(Printer No.) CLASS=(Print Class) LOCAL=1 WIDTH=80 PMODE=2

   d. the last line to add is
   CD ..

LogonPC

7. Call SC and have your LOG ON ID set for LightSpeed.
   SC Must run VSSECURE and change your FILE/LIBRARY/VOLUME to Blank, give you at least two logons, give you Run Program, and Initiate Remote Logon priviledges. (4) (6)
   They must also check $DIRCTLS and make sure your start menu is not EMS, if it is . . . they should put it back to the value set in AMUPROC in AMUMENUX on OFF2.

8. Run Windows
   a. Click on File
   b. Click on New
   c. Click on Program Group
   d. Click OK
   e. The Description should be Light Speed - leave the group name blank and let it default.
   f. Click OK

#DIRCTL# -
Must have a start menu
-- NOT EMS

VSSECURE -
Should be blank (Fil/Vol/Lib)

AMUPROC -
To find appropriate start menu for #DIRCTL#
- User Definition Maintenance
- Maintain an Existing User
- Enter User ID
- Starting Menu " ? "

9. With the Light Speed Group Maximized, add the following two ICONS.
   a. Click on File
   b. Click on New
   c. Click on Program Item
   d. Click OK
   e. Description is VSTW, Command Line is c:\ls\vstw.exe,
      working Directory is c:\ls
   f. press OK
   g. repeat a thru d - not a thru e, a thru d
   h. Description is File Exch, Command Line is c:\ls\FILEX.EXE,
      Working Directory is c:\ls
   i. press OK

10. Reboot after SC has set up your LOG ON ID.

11. Authorize the PC for file conversions by (see Start PC/VS Communications page 4)
   a. cd c:\LS
   b. Run the authorization program by typing VCONAUTH at the C:\LS> prompt

THE BIOLOGICAL EFFECTS OF ADN ON HEPATOCYTES: AN EPR STUDY

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Final Report for:
High School Apprentice Program
Armstrong Laboratory

Sponsored by:
Air Force Office of Scientific Research
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Wright-Patterson AFB, OH

August 1994

THE BIOLOGICAL EFFECTS OF ADN ON HEPATOCYTES: AN EPR STUDY

Sara E. Berty
Carroll High School

Abstract

This project investigated the biological effects of ammonium dinitramide (ADN) on hepatocytes. It was hypothesized that ADN decomposes to form free radicals which would be deleterious to the body. The effects of ADN on the liver were studied because regardless of the route of exposure, once inside the body it will enter the bloodstream and ultimately pass through the liver. The leakage of the enzymes aspartate aminotransferase (AST), alanine aminotransferase (ALT), and lactate dehydrogenase (LDH) was measured to ascertain the viability of WB 344 hepatocytes after a 24 h exposure to ADN. Electron paramagnetic resonance (EPR) spectroscopy was used to determine if ADN induced the production of free radicals. As free radicals are highly reactive, α-phenyl-tert-butyl nitrone (PBN) and 5,5-dimethyl-1-pyrolline-1-oxide (DMPO) were used to trap the radicals produced in the experiments. Incubation of hepatocytes with 2.8 mM ADN for 24 h was toxic to 50% of the cells. Cells exposed to ADN produced free radicals in the presence of both PBN and DMPO. The generation of free radicals using PBN seemed to be pH dependent. Further studies are necessary to determine the effects of ADN on the possible target organs, the lungs and skin.

THE BIOLOGICAL EFFECTS OF ADN ON HEPATOCYTES: AN EPR STUDY

Sara E. Berty
Carroll High School

Introduction

One of the major objectives of occupational health and environmental toxicology research is to determine and quantify risks that may occur as a result of exposure to experimental chemicals (1). These risks must be ascertained as early as possible so that proper safety measures may be taken throughout the research and development of new chemicals. The main goals of studying the biological effects of exposure to the oxidizer ammonium dinitramide (ADN) is to ensure that the current or past exposure of workers is "safe" (ie does not permit an unacceptable health risk) and to detect potential excessive exposure before the occurrence of detectable adverse health effects. It is essentially a preventative medical activity.

The results of this biological effects program could also potentially be used to make a biological monitoring device. Such a device could be used to interpret exposure on an individual basis, which could then be used to estimate for each examined worker the amount of exposure absorbed during a specific time interval or the amount retained in the organism or bound to critical cells in the body or even to soil particles at waste sites. The information may also be used to appreciate the overall work hygiene conditions by analyzing the distribution of the biological results in a group of workers. It evaluates the internal dose received and hence helps to estimate health risks.

The greatest advantage of understanding the biological effects of ADN is the fact that the biological parameter of exposure is more directly related to the adverse health effects which the U.S. Air Force attempts to prevent than any environmental measurement.

ADN is a new type of energetic material (2). Currently, several chemicals including TNT, HMX, RDX, and AP (ammonium perchlorate) are being used as high energy solid fuels, Fig. 1.

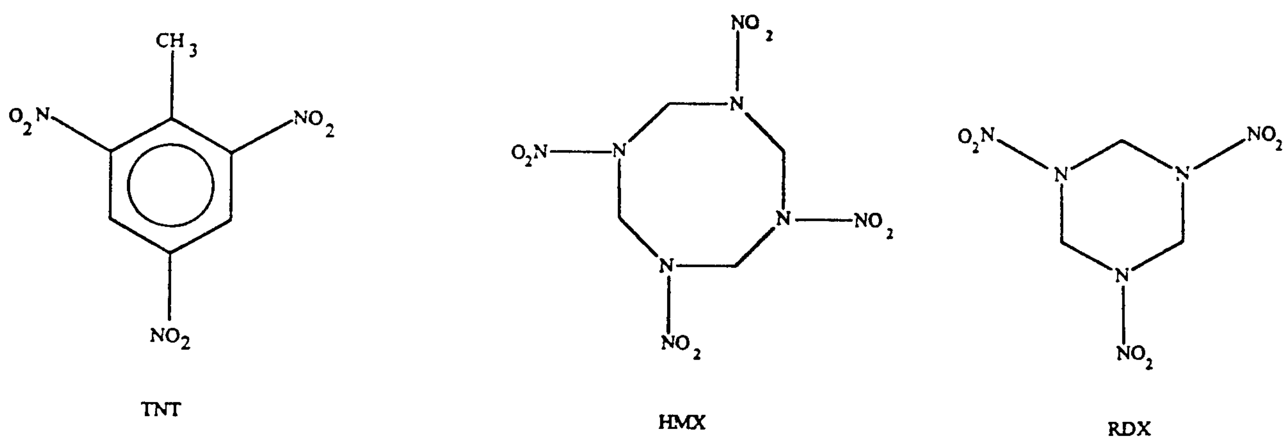

Figure 1. Currently used high energy solid fuels

Recent research is leading to the development of replacements for these compounds. ADN is being investigated as an alternative compound to AP. It is predicted that ADN will be an improvement over AP in weapons systems development or as an oxidizer in the solid fuel of the booster rockets used to put the space shuttle in orbit (2). First, ADN contains no chlorine atoms. Chlorine is a potential pollutant. Second, ADN would not result in the contrail currently produced by AP (2). The absence of this trail will make the detection of rocket launches powered by ADN more difficult. Third, ADN will permit an increased payload capacity which is important for space launches. ADN is an oxide of nitrogen and its chemical formula is $NH_4N(NO_2)_2$ (3). Based on the chemical formula of ADN it can decompose to nitrogen dioxide, NO_2 (4). NO_2 is a free radical. Free radicals can be defined as a molecule or ion containing an unpaired electron (5). Free radicals are very reactive and can cause injury to biological tissue (6-10).

ADN has been experimentally shown to produce NO_2 on exposure to gamma-radiation (4). Although the possible ADN induced free radical reactions can be shown chemically (Fig. 2), it is not known whether they can occur within living cells.

(1) $2NH_4^{+}N(NO_2)_2 \xrightarrow{\text{radiation}} 2NH_3^{\cdot} + 4NO_2^{\cdot} + 2H^{+} + N_2$

(2) $NH_3^{\cdot} + H^{+} \longrightarrow NH_4^{+}$

(3) $NH_4^{+} + 2O_2 \longrightarrow NO_3^{-} + H_2O + 2H^{+}$

(4) $NH_4^{+} \xrightarrow{\text{Urea Cycle}} CO(H_2N)_2$

(5) $O_2^{\dot{-}} + O_2^{\dot{-}} + 2H^{+} \longrightarrow 2H_2O_2 + O_2$

(6) $Fe^{+2} + H_2O_2 \longrightarrow Fe^{+3} + \cdot OH + OH^{-}$

(7) $NO_2^{\cdot} + \cdot OH \longrightarrow NO_3^{-} + H^{+}$

(8) $NO_3^{-} + 3Fe^{+2} + 4H^{+} \longrightarrow NO\cdot + 3Fe^{+3} + 2H_20_2$

(9) $H_2O_2 + NO_2^{-} + H^{+} \longrightarrow ONOOH + H_2O$

(10) $O_2^{\dot{-}} + NO\cdot + H^{+} \longrightarrow ONOOH$

(11) $ONOOH \longrightarrow \cdot OH + NO_2^{\cdot}$

(12) $ONOOH \longrightarrow (ONOOH)^{*} \longrightarrow NO_3^{-} + H^{+}$

Figure 2. Possible pathways for ADN decomposition (Ref. 4)

The best technique to study free radicals is electron paramagnetic resonance spectroscopy (EPR). Radicals in concentrations down to about 10^{-10} M can be detected by EPR (11). In this technique a sample placed in a magnetic field is subjected to microwave radiation. The unpaired electron acting as a magnet can take up two orientations with respect to the external field corresponding to two energy levels. The energy difference between these levels induced by the microwave radiation produces an absorption peak which is detected by the spectrometer (12). As free radicals react very quickly, one way of detecting them is by spin trapping. Spin trapping consists of reacting short-lived free radicals with a spin trap (usually a nitrone or nitroso compound) yielding a longer-lived nitroxide spin adduct which can be detected by EPR (13). There are a number of spin traps which can be used in biological systems (9,13). The most commonly used spin traps are α-phenyl-tert-butyl nitrone (PBN) and 5,5-dimethyl-1-pyrolline-1-oxide (DMPO).

It was hypothesized that the main routes of exposure to ADN would be through the lungs or skin. Study of the biological effects of ADN have to take into consideration absorption by all routes. Regardless of the route of entry of ADN, once inside the body it will enter the bloodstream and will ultimately pass through the liver. The liver is the largest gland in the body (14) and is often the target organ of chemical-induced tissue injury, a fact recognized for over 100 years (15-16). Hazard assessment studies often focus on the liver because it is the organ largely responsible for the detoxification and metabolism of chemicals in the body. While, the biological effects of exposure to ADN in the liver can be studied in many ways, the initial study of the biological effects in cultured hepatocytes is the most logical because it is economical, provides large supplies of samples and requires no animals.

The objective of this project was to study the biological effects of ADN on the viability and proliferation of hepatocytes and to measure the free radical decomposition products of ADN by EPR and EPR/spin trapping techniques.

METHODOLOGY

Cell Culture

WB 344 hepatocytes were isolated and cultured in DMEM (10% fetal bovine serum, 1% penicillin/streptomyocin, pH 7.4). The cells were allowed to become confluent, and diluted to a concentration of 5 x 10^5 cells/mL before use in the cell viability assay.

Cell Viability

Cell viability was measured on WB 344 hepatocytes to determine the integrity of the cell membrane. Using the Kodak Ektachem 700XR, the leakage of aspartate aminotransferase (AST) and alanine aminotransferase (ALT) was ascertained. The lactate dehydrogenase (LDH) assay was conducted on the Dupont ACA discrete clinical analyzer.

Cell Proliferation

A CellTiter 96 Non-Radioactive Cell Proliferation Assay was conducted using a Molecular Devices Thermo max microplate reader. This assay was used to determine the absorbance of the sample which is directly proportional to the number of viable cells.

EPR Spectroscopy

Cell preparations (1 x 10^6 cells/ml) were packed in quartz aqueous cells. Using a Varian E4 EPR spectrometer, the EPR spectra were recorded under the following conditions: microwave power, 20 mW; microwave frequency, 9.54 GHz; scan range, 200 G; field set, 3430 G; time constant, 0.5 sec; modulation amplitude, 1 G; and modulation frequency, 100 kHz.

Results

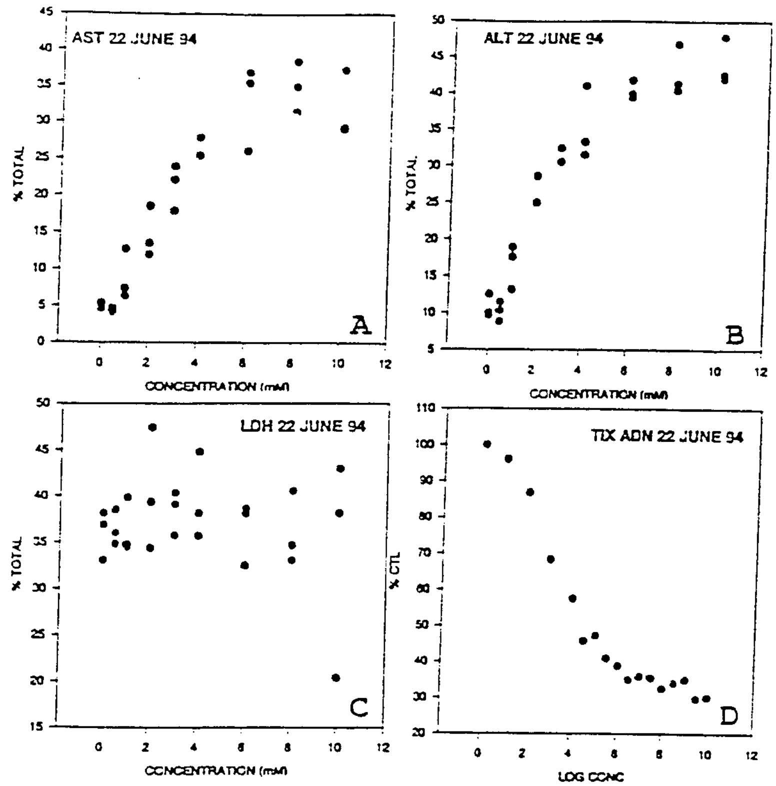

Figure 3. Viability (A-C) and proliferation (D) assay results of WB 344 hepatocytes following a 24 hr. exposure to ADN.

After a 24 hr. exposure to ADN, viability assays were taken to determine the leakage of the enzymes AST, ALT, and LDH. Figures 3A and 3B show the effect of ADN on the leakage of AST and ALT. In both cases, an increase in the ADN concentration is reflected in the greater percentage of enzyme leakage. Figure 3C shows the results of the LDH viability assay. Irrespective of ADN concentration, the assay gave the same LDH leakage value (37±10%). The results of the cell proliferation test are displayed in Figure 3D. As ADN concentration (mM) in the media was increased, there was a decrease in the number of surviving cells.

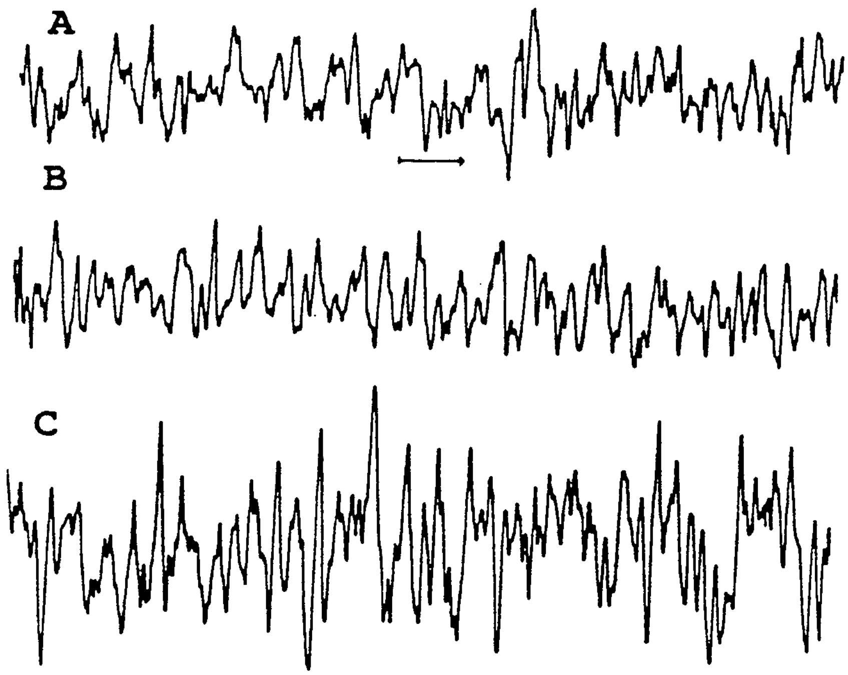

Figure 4. EPR spectra of hepatocytes and PBN (4A), ADN and PBN (4B), and PBN and hepatocytes with ADN (4C).

Figure 4 displays EPR spectra gathered under the following conditions: scan range, 200 G; field set, 3430 G; time constant, 0.5; modulation amplitude, 1 G; receiver gain, 10 x 10^4, microwave power, 20 mW; and microwave frequency, 9.54 GHz.All tests were conducted at room temperature. Figures 4A and 4B, show the EPR spectra obtained when the spin trap 0.02 M PBN was added to WB344 hepatocytes and incubated for 30 min at 37°C,and when 1 M ADN is added to PBN without cells, respectively. For both of these samples, the spectra represent random noise. Figure 4C displays the EPR spectra produced after the 30 minute incubation of ADN in PBN with cells (1 x 10^6 cells/mL). In this spectrum, the presence of spin adducts are not clear although their formation is beginning.

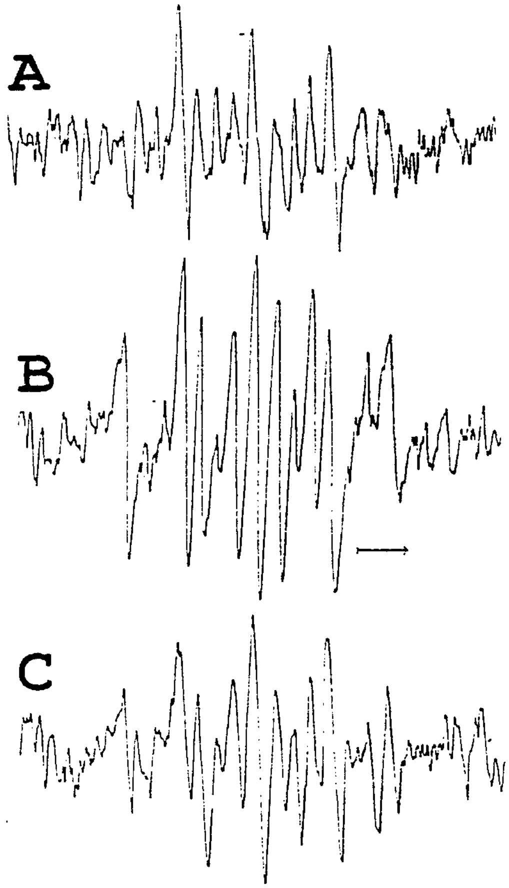

Figure 5. EPR spectra of hepatocytes and DMPO (5A), ADN and DMPO (5B), and cells and DMPO with ADN (5C).

With the exception of receiver gain, the conditions in Figure 5 remained the same as those explained in Figure 4. Figure 5A (receiver gain 1 x 10^4) shows the EPR spectrum of the spin trap 0.02 M DMPO and WB 344 hepatocytes (1 x 10^6 cells/mL) after a 30 min. incubation at 37°C. Unlike the spectrum of the cells and spin trap from the previous figure (4A), this figure shows a nitroxide triplet of hyperfine coupling constant a_N=15.0. The hyperfine coupling constants were measured directly from the spectra as the separation in peaks measured in mT. Figure 5B (receiver gain 8 x 10^4) is the spectrum drawn when ADN and DMPO were tested immediately after mixing. Figure 5B consists of two

DMPO adducts. The first consists of a nitroxide triplet with similar hyperfine coupling constants as those described in Figure 5A. The second DMPO spin adduct consists of a triplet of triplets suggesting the addition of a nitrogen center to the DMPO. The hyperfine coupling constant of these spin adducts are a_N=12.0 for the primary nitrogen, $a_{N\beta}$=5.0 for the secondary nitrogen. Figure 5C is identical to Figure 5B, but less intense, suggesting that the cells compete for the free radicals of ADN in the presence of DMPO.

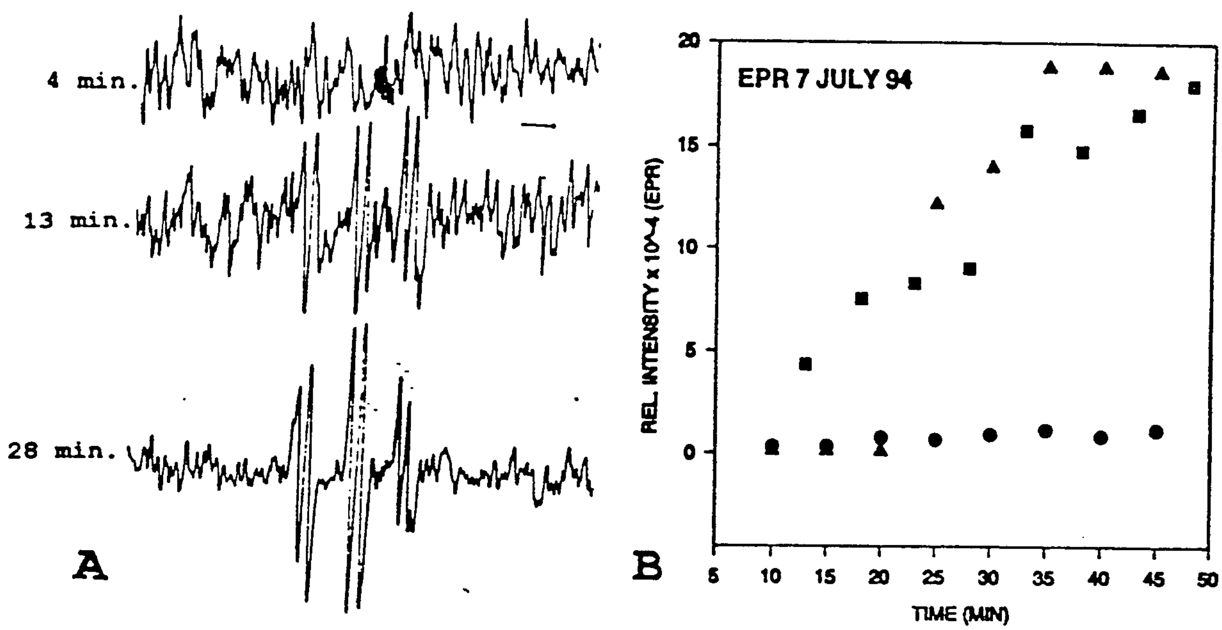

Figure 6. The EPR/spin trapping spectra over time (6A) and (6B) graph of 10 uL NaOH with 1 M ADN in .02 M PBN

Figure 6A shows the spectra from a run in which 10 uL of NaOH was added to .02 M PBN and 1 M ADN. Over time, the peaks increased in intensity. The relative intensity, calculated from the peak height divided by the receiver gain, reached a maximum at 5.64 x

10^{-4}. Figure 6B is the graph of the relative intensity of the EPR signal over 50 minutes, for three different concentrations (5.2 uL, 10 uL, and 20 uL) of NaOH in PBN and ADN (pH=8.6, 9.3, and 9.7 respectively). In all cases except the 5.2 uL concentration, the intensity of the EPR signal grew significantly over time.

Discussion

The effects of ADN on cell viability and free radical production in the liver have been studied using EPR/spin trapping and various viability assays. Based on the literature search, this is the first study on the effects of ADN on hepatocytes. Figure 3 demonstrated the effect of ADN on cell viability as determined by AST, ALT, LDH, and proliferation assays. Three of these four tests showed that increasing concentrations of ADN caused decreased cell viability, while in the LDH assay no trend was visible. Figures 4 and 5 show the EPR spectra gathered under different spin traps. The use of PBN as the spin trap indicated the presence of free radicals only in the sample containing ADN, PBN, and hepatocytes. Peaks were identified in all the samples in which DMPO was used as the spin trap. This is due to the fact that DMPO detects oxygen-centered radicals which are formed naturally in the body, yielding DMPO-adducts with a distinctive characteristic pattern. Figure 6 is the result of an experiment in which 10 uL of NaOH was added to .02 M PBN and 1 M ADN. Over time, the intensity of the peaks grew larger, indicating the growing presence of free radicals as time elapsed. The pH of the solution appears to be important in determining free radicals in ADN with the spin trap PBN. All tests involving cells had a pH 6.9 ± 0.29 and the spin adducts formed by ADN were unclear.

The tests conducted in this study (Figure 3D) indicate that ADN is toxic to 50% of cells at a concentration of 2.8 mM. EPR/spin trapping data indicates that production of free radicals occurs in hepatocytes in the presence of ADN, and this production increases over time. Further studies must be conducted with various routes of exposure (eg. inhalation, dermal absorption, and ingestion) in order to determine exposure limits and establish safety standards regarding the use of ADN in the workplace.

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CARDIAC MEASURES OF PILOT WORKLOAD: THE WRIGHT-PATTERSON AIR FORCE BASE AERO CLUB STUDY

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CARDIAC MEASURES OF PILOT WORKLOAD: THE WRIGHT-PATTERSON AIR FORCE BASE AERO CLUB STUDY

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Abstract

As flying a modern aircraft becomes an exceptionally demanding task, both the mental and physical workload of the pilot and flight crew becomes more complex and demanding. Since the physical/mental workload is difficult to ascertain and measure, the psychophysiological data are preferred since they can be used to show pilot/crew workload. The Psychophysiological Assessment Test System (PATS) has been developed to obtain and then analyze these types of data. In this case, the PATS will be used to measure the pyschophysiological data, particularly the cardiac measures, obtained during the Wright-Patterson Air Force Base Aero Club Study. This study gives researchers the opportunity to compare physiological data collected from private pilots flying a small, non-military aircraft with similar data collected from pilots flying military missions in high performance military aircraft.

CARDIAC MEASURES OF PILOT WORKLOAD: THE WRIGHT-PATTERSON AIR FORCE BASE AERO CLUB STUDY

Michael J. Bruggeman

Introduction

The PATS is designed to meet a large variety of needs for the researcher. These include, but are not limited to the collection of data, graphing, viewing, and editing edit tables, electroencephalogram (EEG) artifact rejection, electrooculogram (EOG) correction, decimation of raw data, baseline correction, digital filtering, combining wave forms which includes Evoked Potentials (EP's), and performing eye blink analysis, heart rate analysis - electrocardiogram (ECG), respiration analysis, the measuring of peaks, a spectral analysis, and a performance data summary (PATS Users Manual). See figure 01 for a typical PATS display. Psychophysiological data provide a way to directly measure the internal state of the operator, and, as such, can be a powerful tool for evaluation of aviation systems. To further illustrate this point, a test known as the Aero Club Study took place. The Wright-Patterson Air Force Base Aero Club is one of the oldest flying clubs in the Air Force. The fleet of twenty-two aircraft ranging from Cherokee 140's to a cabin class Navajo capable of 20,000 feet at 220 knots is the largest and most modern of any flying clubs in the United States Air Force (Wright-Patterson AFB, Morale, Welfare, and Recreation).

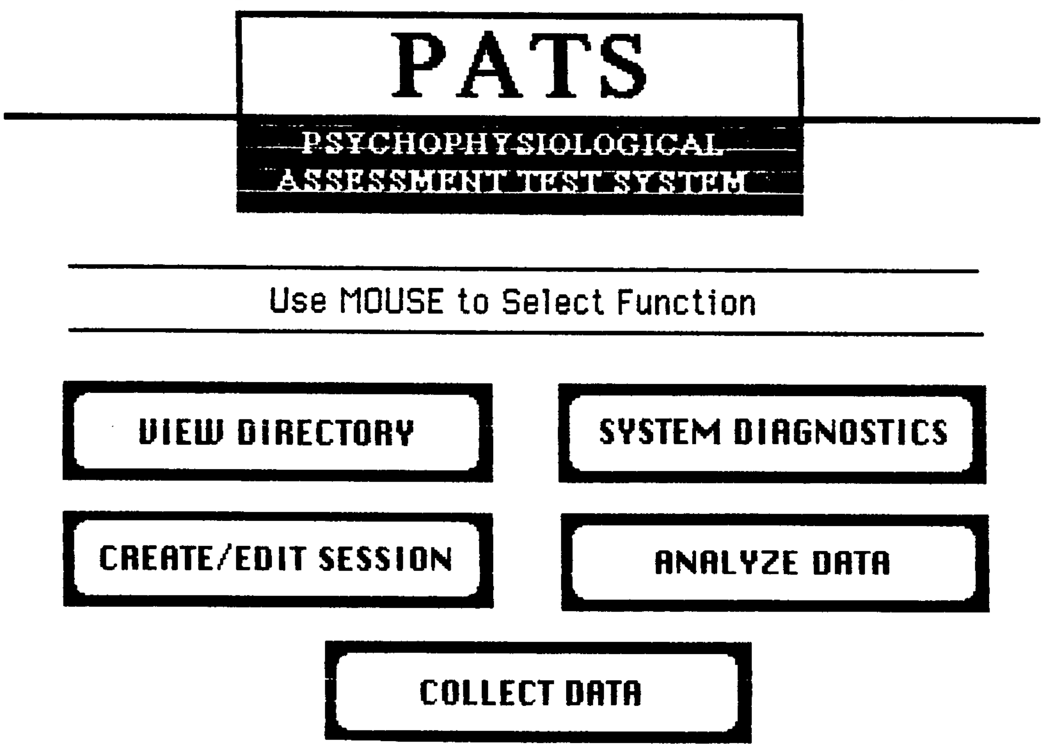


Figure 01: Shows the startup display for PATS

Methodology

Nineteen pilots of the Aero Club volunteered to be subjects in this study. All the participating pilots had passed their Class I physical examination and were qualified to fly the Piper Arrow III, having at least 71 hours experience in this type of aircraft. The pilots' mean age was 34 years with a mean total flying time of 690 hours and 110 hours of instrument flying (Wilson & Hankins, 1994). The flights originated at Wright-Patterson Air Force Base (WPAFB), then proceeded due south towards the farming community of Waynesville, Ohio. At Waynesville, the flight plan took the pilots northeast to the village of Jamestown, Ohio. The pilots then headed northwest towards the Springfield Ohio Air National Guard Installation where the pilots performed the touch and go landing and other airwork such as the DME Arc. From the National Guard Airbase, the pilots returned to WPAFB for their final approach and landing. See figure 02 for the detailed flight plan. The flight took approximately one and a half hours to complete. The flight portion was divided into two distinct segments, Visual Flight Rules (VFR) and Instrument Flight Rules (IFR), during which the pilots wore a vision inhibitory hood and had to operate the aircraft solely on their instruments. The flight segment order went as follows: ground baseline, preflight checklist, engine runup, VFR takeoff, VFR climbout, VFR cruise, VFR airwork, VFR touch and go landing, IFR airwork, IFR cruise, IFR hold, IFR DME arc, IFR ILS tracking, IFR climbout, IFR high speed hold, IFR high speed DME Arc, IFR high speed ILS tracking, and IFR-VFR transition landing. During the high speed segments, aircraft speed was increased by 50 percent. Each pilot was instrumented to record EEG, vertical and horizontal eye movements, and ECG. Del Mar Neurocorders were used to record the data, while the analysis of the data was completed on the PATS. Only the available preliminary heart data will be reported here.

The raw heart rate (HR) data were digitally filtered with a bandpass of 4.21 - 39.68 Hz before being input to the PATS for analysis. The purpose of the initial filtering was to remove extraneous noise, such as severe muscle movements, that interfere with the true heart data. Additional checking was accomplished by visually plotting the interbeat interval (IBI) data for each quantified segment file and looking for abnormally high peaks which would indicate a missed or erroneously marked heart beat. Once an abnormally long or short IBI is determined, the raw data file is examined to determine the actual interval and then the faulty data are replaced with the correct values. It is extremely important that the data file represent heart periods in milliseconds (msec) which are artifact free. Unedited heart period data may include errors of timing heart beat intervals.

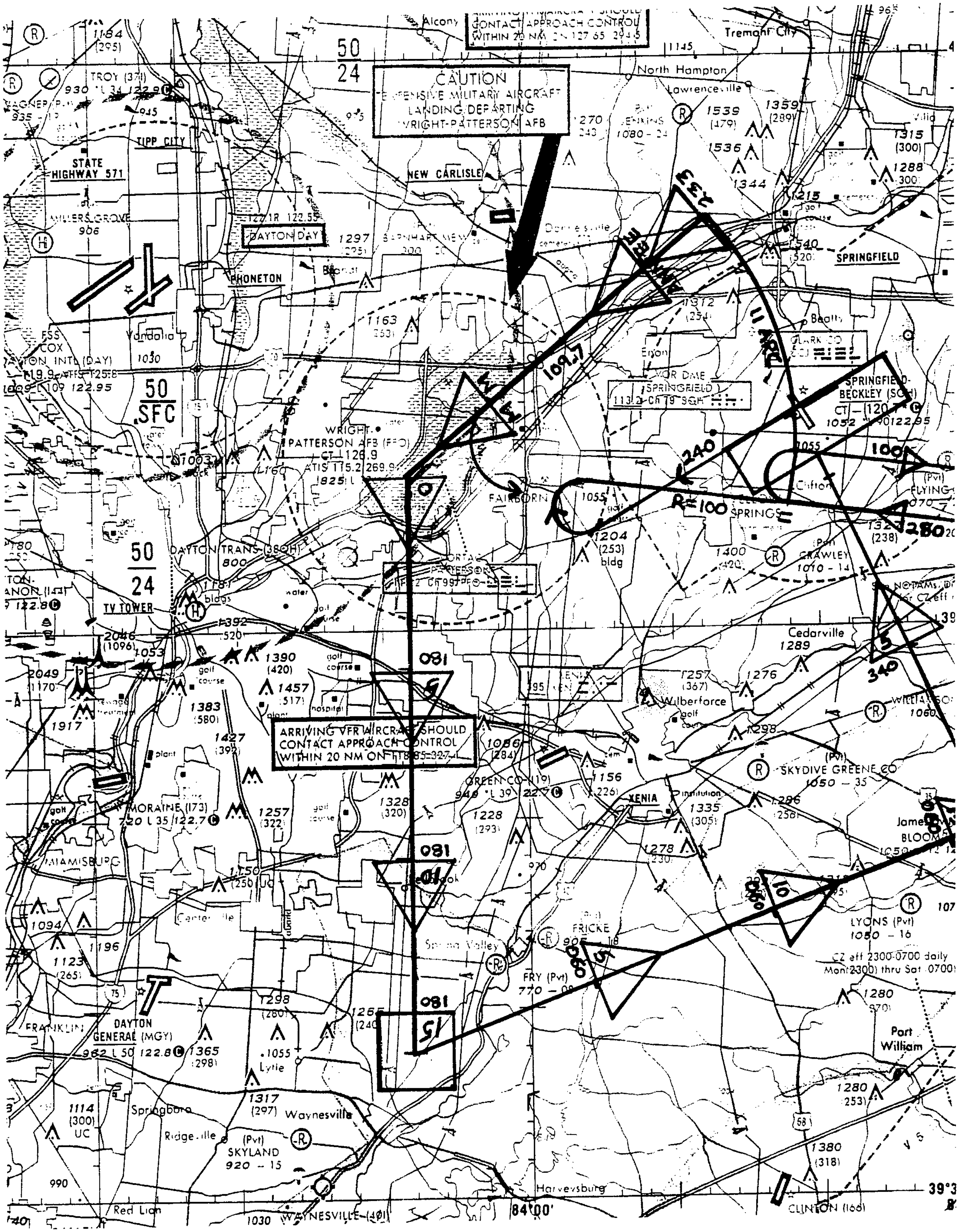


Figure 02: The Flight Plan for the Aero Club Study

Figure 03 shows a raw data segment with noise before the corrections were made using the PATS. These errors will greatly distort any analysis. After analyzing each segment of HR data, the next step is to run the PBfilter - Porges-Bohrer filtering procedure - that is resident on the PATS. PBfilter uses the patented Porges- Bohrer algorithm to band-pass filter heart period, i.e. R-R intervals (interbeat intervals) data by using a moving polynomial to remove non-stationaries (PBfilter: Users Manual). Two band pass parameters were applied to each segment of the flights. The first band pass filter was set to .06 Hz to .14 Hz. The second band pass filter was .15 Hz to .40 Hz. The other parameters were the same for both band passes: the sample period was set at 500 msec; the start time at 0 msec. The end time and the epoch differed between files because of changing file lengths. However, the default setting was used for these two variables. Figure 04 shows the PATS menu for this type of analysis.

Results

Acceptable data were obtained from all participants with a few exceptions. Data from Flight # 4 had to be discarded since the electrodes on this pilot did not stay in place through the whole flight. The flight could not be conducted again because the subject, who was an Air Force pilot, was transferred before arrangements could be made to reschedule his flight. Also, Flight #s 17 and 18 were not included in statistical analysis since the pilots were in their 70s, and had accumulated many more flight hours than the rest of the subjects. Therefore, data from Flights 17 and 18 would have skewed the mean and standard deviations of the rest of the population.

The heart beat variability (HRV) is the beat-to-beat fluctuation of the heart rhythm and is found to decrease under conditions that could be expressed as mentally loading or stressful (Wilson, Fullenkamp, & Davis, 1994). HRV can be obtained in many ways. For the Aero Club Study, spectral analysis of the variations were used, which seems to be the best method for interpreting heart rate variability. The analysis of the mean response of the heart rate variability showed that heart rate was a sensitive measure of pilot stress in that it discriminated between levels of high and low stress levels both within a mission and between missions. Statistical evaluations of the flight segments revealed that four levels of cognitive workload were differentiated by the heart rate data. Results showed that the pre-flight briefing yielded the lowest heart rate, with low level flying and cruise segments also being less mentally demanding for a pilot. Results also indicated that runup, take-off and VFR airwork were periods of higher mental

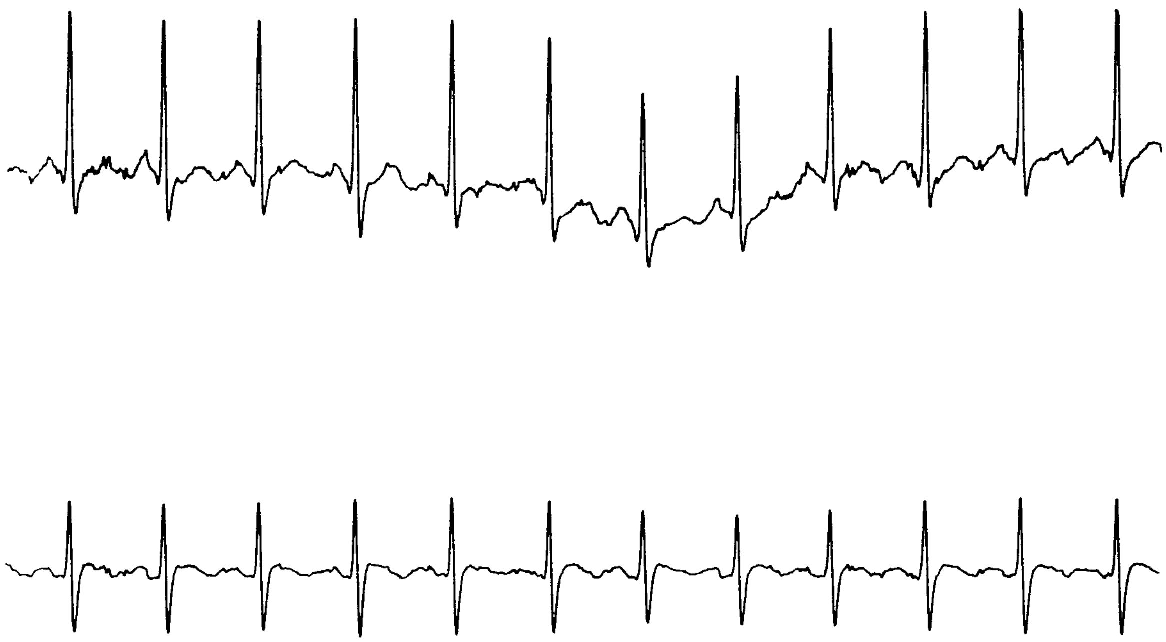
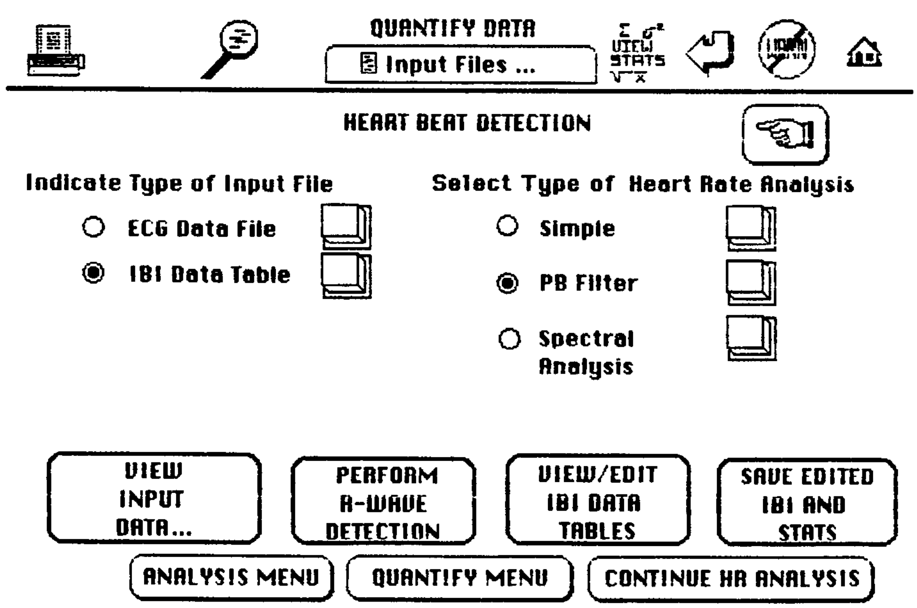


Figure 03 (Above): The first line of data shows noisy, unedited heart rate data while the second line shows the filtered heart rate data.

Figure 04 (Below): PATS introduction screen for the PBfilter.



demand, and the ordering of segment difficulty agrees with subjective evaluation of the mission. In addition, these data show similar patterns of responsiveness by flight segments. Please see figure 05 for a detailed look at the results of the mean response of heart rate variability. Also included in these preliminary data is how different segments of the flight compare or contrast in mental difficulty with one another. The most obvious difference can be seen in the VFR takeoff when compared to the other flight segments. These data clearly show that take off is indeed the most mentally stressful period of the flight for the pilots because, in part, it is the most dangerous period for the pilot, and the pilot is concentrating intently on the mission at hand so as not to crash and die. This might sound a little harsh, but the data seems to back up this hypothesis. These data also show that the mental workload does not seem to affect the heart rate variability as does mental stress. This is evident in the fact that during high mental workload conditions such as the IFR HS DME arc and the IFR HS hold the heart rate variability seems high which seems to indicate very stressful situations, as evident with the takeoff and landing of the aircraft. Please see figure 06 on page 3-10 for a look at the data. When compared to the results of a similar study conducted with F4 fighter pilots, the data are remarkably similar. Results from that study also show that the pre-flight briefings yielded the lowest heart rate, while take off, weapons delivery, and the landing were periods of higher mental demand. Results also compared remarkably well with the airwork performed throughout each study. The airwork and cruise level of each study was a period of less mental demand on the pilot (Wilson & Fullenkamp, 1991).

Conclusion

The results that the Flight Psychophysiology Laboratory received from the Aero Club Study and other studies similar in nature, will demonstrate the utility of multiple measures which tap into different aspects of the human operator's reaction to demanding situations. Learning how and why pilots experience higher level of mental workload and stress during different flight segments will give researchers a chance to develop systems that will help protect the pilot from getting himself or herself into potential deadly situations. This type of research, and the products that can be developed because of it, can help the pilots and the institutions that they fly for, both military and commercial, fly into the 21st century knowing that their aircraft, and especially the pilot, is the best he or she can be.

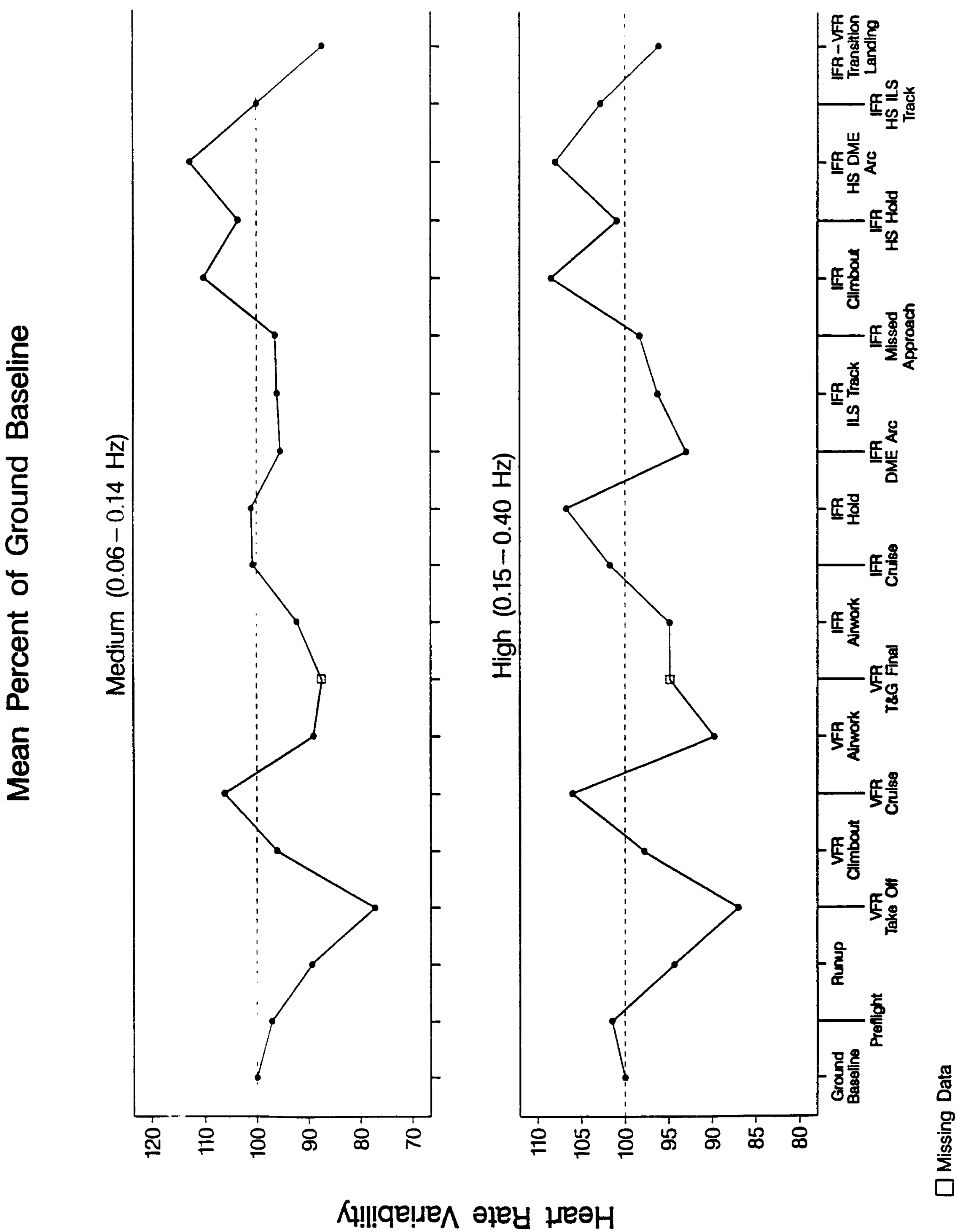


Figure 05: A graph of the mean heart rate variability for all 15 flights.

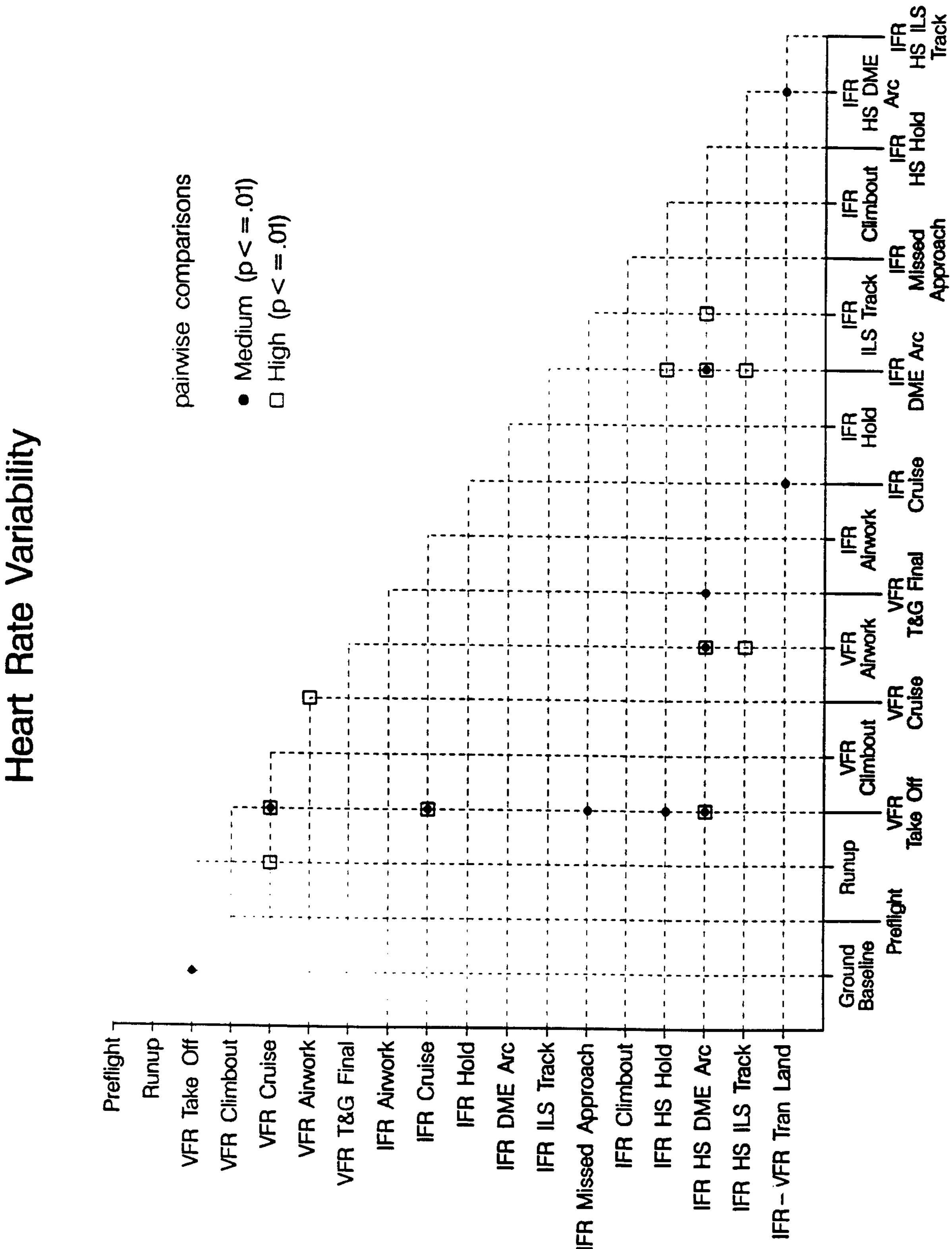


Figure 06: This graph show the different flight segments and how they compare to each other.

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THE DIRECTIVE ROLE OF STATISTICS IN MEDICINE

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THE DIRECTIVE ROLE OF STATISTICS IN MEDICINE

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Abstract

Statistics in medical research has revealed to physicians and researchers what they are capable of accomplishing through the analyzation of quantitative data. Statistics provide methods for detecting the probability of error in research results. The diversity of statistical applications allows almost any type of scientific research to be analyzed. With the interpretations that statistics provide, the conclusions of a scientific findings in medicine are substantiated; thus reducing scientific error and increasing the speed of research advancement.

The Directive Role of Statistics in Medicine

Heather E. Castellano

The importance of accuracy in medical research calls for the use of a mathematical methodology to reason logically its interpretations. Statistics, a "language of assembling and handling quantitative data" is this systematic measurement that is becoming essential to the knowledge of both physicians and medical researchers (Colton 1). Statistics have become the defining line between error and solution and go beyond the realm of what physicians and researchers can do by simply reviewing data for conclusions. The quantitative measures needed to validate medical research lie in what range the statistical association allows.

The majority of developments in statistics have taken place over the past fifty years; although, the concepts of statistics have been in use for centuries. The development of statistics has been a gradual growth in need to have principles by which medical researchers could analyze their scientific findings. Its first contributors were not dealing with a newly found method of statistics but concepts that later evolved into what defines the basis statistical analysis. Its origins may have been sparked by Avicenna, an Arabic doctor of the eleventh century, who formed guidelines to perform medical experiments. These guidelines suggested the use of repeated testing trials and a control group to compare to the variables of the experiment (Cochran 3). In the 17th century, Francis Bacon established the basis for practical experimentation, with the use of controls to compare differences present in his experiments (Cochran 3). An 18th century agronomist, Arthur Young, sought to discover the best farming methods. He stressed the importance of careful measurements and comparative tests, and he understood that the only way to be certain of a result was to compare what he was testing to its opposite (Cochran 4). Statistical analysis was not a part of Young's technique, but he noted the need to eliminate biased conclusions. Many more scientists during this time, especially in medicine, emphasized the need of a quantitative measure in determining accuracy. The early epidemiologic role in medicine seemed to be based on the analyzation of measurements (quantitative data) to determine causal relationships with epidemics (Hennekens 7).

During the 19th century, statistical concepts arose and methods were established, such as standard error tests and standard deviation. Also developed was the population's average probable error quantity to which the error of the mean could be compared (Cochran 9). Finally with Pearson's development of chi-square statistical analysis and methods of estimation and Galton's correlation coefficient test, statistical techniques made their start (Neyman 161).

It was not until the twentieth century that statistics would claim a definite role in scientific and medical experiments (Harshbarger 135). Sir Ronald A. Fisher became known as one of the greatest contributors to the development of statistical techniques. Among the many techniques he developed are the Fisher's exact test for analyzing two by two tables and Fisher's method for assembling probability values for a comprehensive view of statistical significance of experimental results (Bailar 407). At Johns

Hopkins University, Professors Raymond Pearl and Lowell Reed introduced statistics to medicine. They established the first department of biostatistics and enabled Johns Hopkins School of Medicine to become a world leader in medical research (Harshbarger 135). With the growing technology and quantitative means by which to test patients, medicine found the role of statistics to fit perfectly to what doctors and researchers wished to achieve during the 20th century "renaissance in medical research."

The role of statistics in medicine can be described by using the supreme court as an analogy. No matter how efficiently the investigator gathers the evidence to support its defense, the "judge" (statistics) is the final indicator. Until statistics were in use, one had to assume that if a certain medicine cured several cases of ill patients, it would also prove to do so in the entire society. Most likely testing all of the world's population to ascertain the effectiveness of a drug is impossible, but the use of statistics allows the testing of a segment of that population to generalize about a larger population. By using specific calculations that fit the type of research being done, statistics reveal whether or not, and to what extent the results are due to chance.

The basic function of statistics is separated into two areas, descriptive statistics and inferential statistics. Descriptive statistic defines the primary procedures involved in statistical analysis, where the "organizing, summarizing, and describing of quantitative information" takes place (McCall 6). At this point, basic relationships and averages can be determined. A major type of descriptive statistics used frequently in medicine is vital statistics. Vital statistics are concerned with issues such as births, deaths, marriages and divorces. Its role is to document and tabulate these vital events as they are reported (Last 135). These statistics are retained for many reasons, such as measuring the deviation of these vital events from their normal frequencies to examine a possible cause and correction. This could help tremendously in detecting epidemics if there was a sudden increase in the death rates. Vital statistics provide medicine with a foundation to base further research and offer an updated report of what is happening in the world that it is striving to assist. The second, inferential statistics, encompasses a more extended form of analysis. As its name indicates, it allows inferences to be made about a large population based on studies performed on a portion of that population. Inferential statistics can also determine to what degree a relationship exists and whether it is plausible to say that one does exist (McCall 6).

Probability is perhaps one of the most basic concepts among those involved in statistics. Colton states, "The probability of an event is the event's long-run relative frequency in repeated trials under similar conditions." Its role can be found under inferential statistics because it is the probability of an event (data, information, etc.) that is trying to be found. The concepts of probability rest on an idealized experiment. Probability determines the frequency that an event will occur relative to all other possible outcomes (McCall 187). A classic example of elementary probability is the possible outcomes of flipping a coin. The two outcomes are heads or tails since there are no other ways for it to land. The coin is as equally likely to land on the heads side as it is on the tails side. Therefore, the probability or chance that the outcome will be heads is one out of two tosses (ideally) and likewise for tails. For biostatistics, as well as other statistics, probability indicates the level of error or the level that chance alone may have contributed to the data and can be viewed as a percentile (0%-100%). In many cases, if data is found to be less than or equal to the 0.05 probability level, or 95% confidence level, indicating a chance of five percent error, what is being tested can be recognized as significant and that the influence of chance was minimal. Yet, if after placing the data through the equations one finds the probability to be greater than the 0.05 level, the original hypothesis is rejected and replaced by the null hypothesis (Glantz 129).

The necessity of statistics in medical research is immeasurable. Statistics have become so powerful that people are skeptical to give credence to conclusions made without statistical analysis (Salsburg 220). With the budgets set for any medical research, the legitimacy of an experiment must be considered carefully. If research is to be performed and concluded upon, the conclusion should be competent to prevent the risk of eroding funds unnecessarily (Glantz 3). For example if a medication is tested for its effectiveness and found to be effective, it may be satisfactorily accepted and applied for medical use. However, if the conclusions about this medicine were based on faulty observations which could make it appear effective erroneously, the experiment is flawed . This is where statistics make a difference. It completes the scientific procedure of experimentation, such as planning an investigation, executing the plans, and interpreting data based on statistical analysis. In statistical measurement for example, questions like how is a new drug better, to what extent is it better, and what are the laboratory errors in the drug testing , come together to form its basic purpose.

Medicine is becoming increasingly quantitative. Numerical data on many conditions can be obtained with the development of new technology. Statistics can measure probability based on qualitative or quantitative based information. Advanced technology allows physicians and medical researchers to be very accurate when examining or testing an individual. Not only has the precision increased, but measurements can be taken more easily which allows more data to be taken. These precise measurements taken on research subjects, such as measurements extending beyond a hundredth of a digit, can become quiet complicated to analyze by only calculating an average and rationally accepting an explanation. Error in the professional's consideration is only a problem if it is not discovered. A margin of error will probably be present in any research. Through statistical analysis, the physician or researcher can enter data into the proper test equation and from the answer, reveal a probability indicating how accurate the results are around the mean data quantity. Statistics do not decipher the etiology of a disease or why an epidemic has occurred but can detect and eliminate the role of chance in the results (Colton 33). Therefore, when dealing large amounts of data, statistics protect against biased conclusions.

Statistics help expose both limitations and weaknesses of an experiment; this eliminates the chance of criticism that it may normally receive from other researchers in the same field. One reason for presenting research is for the point of finding mistakes revealed by other viewpoints before declaring the conclusions of research. Because many of the errors have already been revealed by statistics, the focus could then rest on how it can be improved. Statistics will not detect every error , but it will definitely improve the quality of the experiments and allow more time for editing other details that were not found with the use of statistical applications (Bailar 25).

The most important reason for statistics in medicine is that medicine deals with the serious matter of improving human health. Mistakes can be detrimental to human survival, the environment and the finances of everyone. If a technique seems to improve a disease, yet later produces adverse effects, the health of the patient is endangered, along with the reputation of medicine. Medicine should be highly respected for its insight and improvements in human health over centuries; however, the public can lose confidence in it due to an occurrence of an unnecessary disaster that would have been corrected had the proper measures been taken to ensure the its validity. Medicine gives people not only health but prospect; therefore, mistakes such as these can not be afforded. Biostatistics can be analogized as warning sign that appears on a computer, alerting the user of a consequence due to possible error. Without this discretion, the user may not realize their mistake until damage has been done. Error is sometimes inevitable even in the cautiously performed experiments, but statistics are a measure of detecting it.

Biostatistics can be used to reduce the role of confounding (Hennekens 35). This refers to concluding a difference in experimental data that does not actually exist, or not discovering a difference that does exist. This observed association or lack of association exists due to some other extraneous factor (Hennekens 35). It is important to consider all aspects of a result of an experiment before proclaiming the results to be exclusively caused by one factor. For example, it has been concluded that eating beta-carotene enriched vegetables can lower the risk of cancer. However, there are many other factors to consider that may have some combined effect on lowering the risk of cancer , such as other components in the vegetables like fiber. Another fact to consider is that many people taking health cautions are younger; therefore, the lowered risk might only be due to the age at which testing is taking place (Hennekens 36). The importance of statistics in this matter is that each aspect can be compared to the problem. Its impact on the change in cancer development can be calculated, and its probability obtained to make a correct conclusion.

The realm of statistical analysis used in medicine is beyond what this paper can incorporate, but there are some very basic methods which can be described. All of the calculations used for analysis of data in statistics are defined under the context of inferential statistics. When preparing to use statistical analysis in a research project, many considerations on the type of data that was taken and how it was taken must be made. One key element used in most all analysis in medicine is standard deviation.

Standard deviation is derived from the variance within a population sample. Variance is defined as " a measure of variation shown by a set of observations, defined by the sum of squares of deviations from the mean, divided by the number of degrees of freedom in the set of observations. " (Last 133). This means that to attain variance in a collection of numerical data, first the mean or average for the data must be calculated by dividing the total of the data by the number of observations comprising the data or in mathematical form, $x = \Sigma\ x/n$ (Colton 29). Variance can now be calculated by taking each number in the data set and subtracting it from the mean. This number is then squared to remove any negative numbers that may be present and divided by the number of observations in the sample minus one, also referred to as degrees of freedom. Mathematically variance (V) is $\Sigma(\bar{x} - x)^2 / (n - 1)$ (Colton 31). Finally, standard deviation can be computed by taking the square root of the variance (Colton 32). Standard deviation reveals how the data is scattered around the mean (Last 123). This is necessary to determine whether the data collected is remaining fairly constant or is spread along a larger range of data. Both are used in later calculations of statistical analysis.

In statistics, there are various tests that are used according to the type of data being analyzed. Many times, the test chosen to analyze data with depends on what type of information the researcher desires to find because within the same set of data, many different tests may be applicable. Analysis of variance is often utilized in medical research when the data falls into a normal distribution, indicating that the data is for the most part centered equally around the mean. Analysis of variance is a statistical method that estimates the effect that various groups of independent variables have on a constant dependent variable (Last 5). It does this by disclosing any differences present in the means of the independent variable groups that are being compared (Scheffe 5). Several assumptions take place when using an analysis of variance; first that the dependent variable is a continuous response (example: reactions to a drug) and also that the obtained data follows a linear model (Anderson 219). One of the simplest forms of analysis of variance is the one way analysis of variance. This incorporates using only one test, the F-test, under the presumption that all of the groups have a common mean and are comparable (Bailar 220). For example, it can answer how specific groups of people may react to a constant dose of one drug. Another form of analysis of variance is a two-way analysis of variance that compares the means of each group against two distinct categories of variables (Bailar 226). In this instance, instead of only answering and estimating how specific groups of people may react to only one aspect of a drug, it can be used in circumstances when subject groups are given several different drugs at two different dosages and the effect that two different variables have on a result is then tested (Bailar 226).

Several other important and frequently used statistical tests in medicine can also be considered under the sphere of analysis of variance. One of the most often used tests in medical research is the t-test. The t-test is used primarily in cases where numerical data is taken by measurement or is quantitative to test a hypothesis. It is used to test the null hypothesis, that there is no difference in the observed and expected results (Colton 130). The t-test is often used in cases when subjects undergo a single treatment, and the difference in before the treatment and after the treatment is needed (Glantz 333). The chi-square test denoted by χ^2 ,is essentially used for the same purpose that the t-test, except it is used in cases when numerical data is qualitative rather than data taken from measurement. This means that the chi-square test is usually used on data that has been based on observations that are counted. Chi-square is used in testing hypotheses and can conclude how "two or more populations differ from each other," by comparing data to a chi-square distribution table after determining its degrees of freedom (Last 23). The table indicates the probability level based on the calculated chi-square value and the degrees of freedom value. To obtain the chi-square value, the following equation is used: X^2= sum of (observed - expected frequency)/expected frequency (Glantz 122). The observed being the results of the experiment and the expected frequency representing what the results were presumed to be. Both the t-test and chi-square are very important to the use of physicians and medical researchers since a lot of research taking place in medicine is based on the comparison of two groups and how each differs. This provides information on whether or not a new technique, or whatever is being tested, is really advantageous and to what extent. Most experimental information can not really be guaranteed to fulfill a certain purpose by merely looking at differences between a control and variable group because there are too many specifications that may cause a difference in results. A very large difference between two different populations could appear to be significantly different, but when calculated in statistics prove the opposite for a large number of reasons, from sample size to experimental errors.

Statistical methods in medical research can be subdivided into parametric (fits a normal distribution) and nonparametric. Nonparametric is used to analyze data that does not meet an assumed distribution, and does not equally lie around the mean (Glantz 288). Since it would be inappropriate to compare this data to a normal distribution, different methods of nonparametric or distribution free methods are utilized. (Glantz 289). One technique makes use of ranking the data instead of using the actual measurements. This makes it possible to make inferences about the relative frequency of the information and does not require any presupposed ideas about the results. Information does not have to follow a specific shape in distribution, as long as distributions maintain similar shapes (Glantz 289). Physicians and scientists may use this for the purpose of analyzing the variance in results when no apparent expectation can be set for the data. A nonparametric method of ranking would be ideal in an experiment consisting of nineteen subjects with high blood pressure where a comparison is taken of drug A given to ten and placebo given to nine. Drug A would act as a variable to supposedly decrease blood pressure, and the placebo would present a controlling factor. The rank would place subjects in the order of highest blood pressure to lowest blood pressure regardless of which experimental group they were tested. The rankings in the drug group should be lower if the drug A lowered blood pressure. The probability can be assessed by calculating all the possible ways to combine the ranks, and then dividing that number by the rank sum to get a percentage, which would equal the probability (Glantz 292).

To demonstrate major uses of statistics in medicine, the Cholesterol Reduction in Seniors Program Pilot Study, performed by a group of doctors funded by the National Heart, Lung, and Blood Institutes, investigated the effects of lovastatin in lowering the cholesterol levels of people over 65 years old. It was a randomized and double-blind study. A double-blind study is when both the subjects and researchers are unaware of the type of variable they have been assigned. The experiment employed three trial groups, each group receiving either placebo, 20-mg lovastatin, or 40-mg lovastatin. The study ended with taking blood lipid levels of the 431 participants after one year of treatment. The group receiving placebo appeared to show no change, yet the lovastatin groups exhibited a decrease in total cholesterol levels, by seventeen to twenty percent. There was also a slight variance between those taking 20-mg of lovastatin and 40-mg of lovastatin (Rosa 529). Since this information is based only on observation, it is insufficient to determine the differences between dosages and whether the decrease in cholesterol levels is a significant measure to lower cholesterol levels. The researchers then conducted further examination through statistical procedures. The versatility and variety provided with statistical methods made it possible to analyze several aspects of the data, rather than only one. To compare the effects of each treatment, an analysis of covariance was used because the data was based on a continuous response (Rosa 531). An analysis of covariance is used for data, like the above, that is separated into groups containing many differing factors such as gender or possession of a coexisting medical difficulty that may bias the observations; this is referred to as being randomized (Bailar 42). Although no significant difference was found between the differences in drug dosage, there was a significant difference in the decline of cholesterol levels among those taking lovastatin and those taking placebo (Rosa 531). A categoric test of analysis was attained in regard to determining if any side effects were present while taking the drug. This basically categorizes different instances that were observed during the trials and calculates whether this discrete evidence is significant to its specific treatment (Rosa 538). Without the use of statistical analysis, doctors may have concluded that lovastatin produced side effects because some of the subjects did seem to have slight abnormalities. Statistics substantiated that these abnormalities could not appropriately be considered as side effects. Even though this was a small scale experiment, the results made through statistics introduced further important research in interest of the most effective ways to reduce cholesterol level in those who are older than 65.

The Predictors of Operative Survival After Valve Replacement is another example of a research study that successfully included statistics into the results. This was a four year study observing 2,488 patients receiving three types of valvular surgery: aortic valve surgery, mitral valve surgery, and double valve surgery. The purpose of this study was to determine the effect that individual factors, such as age, gender and procedure, had on the survival rate after the valvular surgery. The large sample size was a measure to eliminate the emergence of biased results. The statistics derived from these observations may be more accurate since the probability is essentially concluded around the mean. The patients were observed and tested for thirty days after their surgery and the operative mortality was tabulated. Also tabulated were complications such as infection, stroke and myocardial infarction. With the use of a chi-square test based on a 0.05 probability level, the mortalities were compared their independent variables (ex: male or female). It was found that the mortality rates in the double valve surgery were significantly higher that the other two valvular surgeries. Procedures in relation to the valvular surgery were also considered during the statistical analysis (Magilligan 25) Age differences proved to be insignificant in predicting the operative mortality rate. There were some differences present in relation to age, but statistics revealed that these were not significant. Since this study encompassed so many aspects in relation to the three valvular studies, it would be virtually impossible to assume any conclusions and relations based only on the assumptions of the researchers. Statistics identified whether the apparent relationships were really a factor in mortality which later helped physicians with strategies to improve techniques (Magilligan 33).

With the broad scope of statistical analysis, medical researchers and physicians are given the advantage of exploring what can not be revealed by a microscope or the specialized equipment used during research. It helps answer a major concern of whether the results are significantly derived from error or chance and whether the researchers are valid in their conclusions. Without the verification of statistical analysis, error is apt to mask itself and deceive or retard the doctor from taking part in what is actually taken place. If the absolute and most important goal of medical research is considered, it is found that it is for the correction of problems present in medicine and the advancement of its applications. The most consequential objective of research in medicine is the accuracy it upholds. With this as the objective, one can realize why it is crucial to most medical researchers and doctors to incorporate statistics into their research. "Hunches and intuitive impressions are essential for getting work started, but it is only through the quality of the numbers at the end that the truth can be told." (Thomas 676)

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A PASCAL PROGRAM FOR A PC-BASED DATA ACQUISITION SYSTEM

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A PASCAL PROGRAM FOR A PC-BASED DATA ACQUISITION SYSTEM

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Abstract

A PASCAL program for a PC-based data acquisition system was developed to examine the relationship between heat and efficiency in a Molecular Sieve Oxygen Generating System (MSOGS). The MSOGS setup generated multiple analog voltages that came from various temperature amplifiers, pressure transducers, and flow meters. A 12-bit Metrabyte multi-function I/O card was used with a PC to perform the necessary analog-to-digital (A/D) conversions during the data collection process. The PASCAL program monitored and controlled the Metrabyte card while managing data collection, streaming data to disk, and data storage. The resulting binary data stored on the disk was converted to ASCII format using a binary-to-ASCII converter program. The results of the program repeatedly showed no loss of data integrity during data collection of 30 minute, multi-channeled MSOGS runs.

A PASCAL PROGRAM FOR A PC-BASED DATA ACQUISITION SYSTEM

Christopher J. Chadwell

Introduction

Data acquisition has improved dramatically with the use of the personal computer (PC). PCs have the ability to reliably acquire and process data at very high rates making them a crucial element of the data acquisition process. But the PC and data acquisition process requires software programs to automate the data collection. The software programs collect and covert data to a usable form for later use. The data is converted from analog to digital and most often stored as binary data. The computer acquires this data through internal PC boards that are manufactured solely for analog-to-digital (A/D) conversions. An example of these types of A/D boards is the Quinn-Curtis Metrabyte multi-function I/O card. This card converts analog voltages to binary (0's and 1's) information so that the PC can further process the data. This type of data can be stored very efficiently, and many data collection runs can be kept on a small hard disk drive. The only problem with binary data is that most people can't readily interpret the base-two representation. That is why binary-to-ASCII converters are essential. They change data from the base-two format of binary to the readable base-ten format of ASCII.

The need of a software program was required to reliably collect and store data for a 16-channel Molecular Sieve Oxygen Generating System (MSOGS). Temperature, pressure, and flow measurements make up the 16-channels of data collection. These measurements were necessary to model and verify the MSOGS setup. The MSOGS setup takes high pressure air and feeds it through a set of cycling beds filled with zeolite. The zeolite adsorbs the nitrogen from the air intake and 95%

oxygen is then generated. Variables like heat are introduced and therefore numerous temperature readings must be taken at different points to ensure the entire setup is at operating temperature.

Methodology

The first step taken in preparing an automated data acquisition system was to obtain a PC. For this development, a Zenith 248 was used. A Zenith 248 is an Intel 80286-based Hertz PC. It was used because it was readily available and capable of performing the desired tasks without major modifications. The next step was to develop the necessary software. PASCAL, a high level programming language, was used because it was readily available and came bundled with a enough documentation explaining it. PASCAL was also used because of sample software routines written by the Quinn-Curtis manufacturer which provided steps and procedures to allow the programmer to organize and develop the desired data acquisition software. The third step was to configure the Metrabyte data acquisition card. The 12-bit Metrabyte DAS-20 card was chosen because of its resolution and programmability. The researcher's needs for this MSOGS data acquisition software were continuous data collection of 16-channels of analog voltages at a sample rate of 80 samples/sec/channel for a desired period of time, and simultaneously streaming the data to the PC's hard disk for storage. However, only 64 Kbytes of data could be streamed and written to the hard disk without exceeding the RAM boundaries of the PC. Therefore, it was necessary to develop a two buffer scheme to collect the data and stream it to disk. While buffer one was filling with data, buffer two was writing or streaming data to the hard disk, and while buffer two was filling, buffer one was writing. To see this technique, refer to the repeat loops in the program listing.

Results

Initial results were unexpected. There was a problem with reading the binary data files streamed to the hard disk. These binary files were transferred via network to a more powerful 80486-based PC that had a UNIX-based utility called Pearl installed on it. Pearl converted the binary data to ASCII format. However, the ASCII format of our data showed unusually high values, i.e. 12,000, too high and unreasonable. A value that high would indicate a voltage of nearly 25 volts-- exceeding the boundaries of the Metrabyte card. Further analysis showed that when the data was written to RAM, it's contents were shifted left four bits and the empty four bits were filled with channel information. To compensate, we used the PEARL software to shift the binary data right four bits. Another problem was an occasional spike in the data at every RAM-buffer fill, but the problem was hardware rather than software, and was therefore acceptable. Now that usable data was being recorded, the integrity of that data needed to be tested. The first step in the test was to impress a constant voltage to the Metrobyte card and collect and evaluate the data. This showed that data could be collected for a desired period of time without failure. The next step of the test would be to impress a ramped voltage to the board using a function generator. A ramped voltage is when an initial voltage is slowly and stepwise incremented to a certain level and then dropped to the initial level. If there is a shift in the data over a period of time during data collection, then an analog-to-digital scan was missed resulting in a hole in the data and therefore a loss of data integrity. The data collected had no holes, so there was no loss of data integrity. The last test would be an actual test run of the MSOGS experiment to determine any loss of data integrity. A series of MSOGS test runs using the combination of the PASCAL data acquisition routines and the Metrabyte card showed no loss of data integrity during data collection and data streaming to disk. The software program was successful.

Conclusion

A PASCAL software program for a PC-based data acquisition system for the AL/CFT MSOGS demonstrates data collection and data streaming to disk without loss of data integrity. PASCAL was the choice of programming language since it was readily available; however, the same algorithm could be implemented in other high languages such as C and BASIC. The 12-bit Metrabyte DAS-20 card was used to perform the necessary analog-to-digital conversions. The Metrabyte card coupled with the PASCAL program proved to be a good combination for data acquisition. The completed program listing is included on the following pages.

```
program test (input, output, buffer_dump_file);   (* This program takes a *)
                                                   (* snapshot of the board *)
uses                                               (* and writes the binary *)
    tp4d20,das20ext,dos,crt;                       (* data to disk *)


const
    base_adr = $300; int_level = 3; dma_level = 1; board_num = 0;


type
    buffer_type = array[0..13999] of integer;  (* dsclaring buffer_type *)
                                          (* as an array with 16000 *)
var                                       (* spaces for data *)
    Bufseg, Bufofs : word;

    buffer_pointer : pointer;

    gain, scans, trigger, op_type, mode, cycle, data, count, buffer_flag,
    next_cnt, rate1, rate2, status, err_code, BSQueue, word_cnt : integer;

    end_flag, switch_flag : boolean;

    buffer_0 : ^integer;
    buffer_1 : ^buffer_type;
    buffer_2 : ^buffer_type;

    buffer_dump_file : file of buffer_type;
```

```
begin
    (* 2000 block scans *)  (* trigger with external gating *)
    scans := 2000; trigger := 1; word_cnt := 0;
    rate1 := 125; rate2 := 2000; cycle := 0;

    (* initializing the board *)
    d20mode0(board_num,base_adr,int_level,dma_level,err_code);

    (* allocating memory for the buffers *)
    GetDMABuffer(56000,buffer_pointer,err_code);

    (* setting up pointer for buffer_1 and buffer_2 *)
    Buffer_0 := buffer_pointer;
    Bufseg := seg(buffer_0^);
    Bufofs := ofs(buffer_0^);
    Buffer_1 := Ptr(Bufseg,Bufofs);
    Buffer_2 := Ptr(Bufseg,Bufofs + 32000);

    d20mode1(board_num,0,4,2,err_code);  (* setting the queue for the *)
    d20mode1(board_num,1,4,0,err_code);  (* channels that will be used *)
    d20mode1(board_num,2,4,0,err_code);
    d20mode1(board_num,3,4,0,err_code);  (* first number is channel *)
    d20mode1(board_num,4,4,0,err_code);  (* secind number is gain *)
    d20mode1(board_num,5,4,0,err_code);         (* 1 = +/- 10v *)
```

```
d20mode1(board_num,6,4,0,err_code);  (* third number is the count *)
 d20mode1(board_num,7,4,0,err_code);        (* 0 = middle channel *)
 d20mode1(board_num,8,4,0,err_code);        (* 1 = last channel *)
 d20mode1(board_num,9,4,0,err_code);        (* 2 = first channel *)
 d20mode1(board_num,10,4,0,err_code);
 d20mode1(board_num,11,4,0,err_code);
 d20mode1(board_num,12,4,0,err_code);
 d20mode1(board_num,13,4,1,err_code);
                                      (* initializing clock for *)
                                      (* d20mode27.  Overall *)
 d20mode25(board_num,rate1,rate2,err_code); (* frequency is equal to *)
                                      (* 5000000/rate1 * rate2 *)
                                      (* assigning buffer_dump_file *)
 assign(buffer_dump_file,'stupid.dat'); (* as stupid.dat.  To change *)
 rewrite(buffer_dump_file);             (* destination, change stupid *)
 end_flag := false;
 buffer_flag := 1;
 next_cnt := 0;
                          (* mode27 takes snapshot of board *)
 d20mode27(board_num,scans,trigger,cycle,bsqueue,buffer_1^[0],err_code);

 repeat

   clrscr;        (* clear screen *)
   count := 1;    (* initializes the count for inner repeat loops *)
```

```
repeat
    (* mode12 reads the number of words going through DMA *)
 d20mode12(board_num,op_type,status,next_cnt,err_code);
 gotoxy(30,15);
 write(next_cnt:5); (* write out word count *)
 if (count MOD 100000 = 0)  (* checks to see if next_cnt just *)
   then                     (* printed out matches that of the *)
     if (next_cnt = data)   (* variable previously stored. *)
       then                 (* Only checked every 100000 times *)
         end_flag := true;  (* through the loop *)

 If (buffer_flag = 1)
   then                        (* checks to see if the words *)
     begin                     (* going through DMA have *)
       if (next_cnt > 13999)     (* filled up buffer.  If so *)
         then                  (* it ends the loop by *)
           switch_flag := true   (* changind flag to true *)
    else

       switch_flag := false
     end
else
     begin
       if (next_cnt < 14000)     (* same as above but for *)
         then                  (* buffer_2 *)
           switch_flag := true
```

```
else
          switch_flag := false
       end;

       if (count MOD 50000 = 0)     (* writes word count to *)
         then                       (* the variable data *)
           data := next_cnt;        (* every 50000 time through *)
       count := count + 1;          (* the loop *)

    until switch_flag or end_flag; (* condition for ending the loop *)

   if buffer_flag = 1
    then                     (* dumps buffer_1 if flag is 1 *)
     write(buffer_dump_file,buffer_1^);

   if buffer_flag = 2
    then                     (* dumps buffer_2 if flag is 2 *)
     write(buffer_dump_file,buffer_2^);

   if buffer_flag = 1
    then
     buffer_flag := 2        (* switches buffer flag from 1 to 2 *)
    else                     (* or 2 to 1 *)
     buffer_flag := 1;
```

```
    until end_flag;              (* sets condition for ending the loop *)
    d20mode11(board_num,err_code);   (* cuts of DMA actions *)
    close(buffer_dump_file);     (* closes dump file *)
            (* frees allocated memory back up for cpu use again *)
    FreeDMABuffer(56000,buffer_pointer,err_code);

(* The data is stored in the dump file in left justified binary format *)
(* In order to see the data, you must use the procedure d20convertdata *)
(* from the Quinn-Curtis disks.  If you are using a binary to ASCII *)
(* convertor, you simply shift the data right four places.  Before you *)
(* do that, though, I would suggest taking a short data sample and *)
(* looking at your data. *)
end.
```

EVALUATION OF HEAD SCANS FROM THE HGU-53/P HELMET SURVEY

1994 High School Apprenticeship Program
Air Force Office of Scientific Research

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Harvard University

Sponsored by:

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Human Engineering Division
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EVALUATION OF HEAD SCANS FROM THE HGU-53/P HELMET SURVEY

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Abstract

The recent development of three-dimensional anthropometric techniques by the Computerized Anthropometric Research and Design (CARD) Laboratory at Wright-Patterson Air Force Base uses state-of-the-art computer graphics and laser technology to greatly enhance the capability of Air Force design engineers to improve the fit and effectiveness of essential protective flight equipment. For the first time, this new design tool makes available to both government and private industry crucial data about the shape of the head, that facilitates design of helmets, oxygen masks, helmet-mounted display units, and many other types of headgear. It also lends itself to advanced biomedical applications, such as production of burn masks and prosthetics.

With the use of a Cyberware Echo Digitizer laser scanner, the CARD Laboratory has compiled a large database of head scans from several surveys of Air Force pilots throughout the United States. Once scans are collected, evaluation is necessary to determine whether the data is reliable and useful, and if not, whether it can be made reasonably reliable and useful. This paper focuses on the first evaluation of the quality of three-dimensional head scans, completed on the HGU-53/P helmet survey from the CARD database.

EVALUATION OF HEAD SCANS FROM THE HGU-53/P HELMET SURVEY

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Introduction

In 1936, Captain Harry G. Armstrong suggested height and weight requirements for the selection of Air Force pilots. Since then, anthropometry - "measurement of the human body" - has been an important factor in the design of Air Force crew systems and flight equipment. In those early days, calipers and tape measures gauged the distances between anatomical landmarks. A sculptor then transformed the two-dimensional data into a three-dimensional model to provide necessary information about shape. Although two-dimensional measurement may have been accurate to a few millimeters, rendering it into three-dimensional form magnified existing error and introduced new error.

Today, advancements in technology have made new three-dimensional anthropometric techniques possible. At the Computerized Anthropometric Research and Design (CARD) Laboratory at Wright-Patterson Air Force Base, a Cyberware Echo Digitizer scanner - consisting of a low-powered laser, mirrors, and two video cameras - records data about size, shape, and color. In about twelve seconds, this scanner registers the radial distance from the vertical axis to 256 points along each of 512 lines of longitude. The three-dimensional coordinates of over 130,000 points are calculated to within one millimeter of resolution. A computer workstation displays scanned data in graphic form - in wireframe (Appendix A) or surface mode (Appendix B), in grayscale or full color. With the graphic editing tool INTEGRATE, these scanned images may be manipulated and enhanced for use in various anthropometric studies. Currently, the scanner at the CARD Laboratory has the capability of collecting data for objects approximating the size and shape of the human head. A full body scanner is expected to arrive sometime in 1995.

As part of the Human Engineering Division of the Air Force Crew Systems Directorate, the CARD Laboratory manages ongoing projects to improve the fit and effectiveness of aircraft systems and personal protective equipment. In particular, the CARD Laboratory has performed numerous tests to evaluate the fit and comfort of currently issued models as well as prototypes of helmets and helmet mounted systems. CARD's anthropometric head data allows objective critique of helmet-mounted optical display units. Private industry has approached the laboratory for data to improve the design of headgear, such as helmets and visors. Other organizations outside the Air Force are also interested in three-dimensional anthropometric data for biomedical applications. Making burn masks based on three-dimensional data from the scan of a burn victim improves the fit and efficacy of the mask. It also prevents the discomfort and possible tearing of tissue associated with plaster casting production of burn masks. Three-dimensional anthropometry also shows promise in the manufacture of prosthetics, hearing aids, and other medical devices.

In order to provide thorough data on the size and shape of various human heads, the CARD laboratory has compiled a database of head scans from several different surveys. The recent HGU-53/P helmet survey consisted of 185 subjects from various locations: Griffiss Air Force Base, Eglin Air Force Base, Hurlburt Field, and Shaw Air Force Base. These subjects were first marked with blue dots at 32 anatomical landmarks and fitted with a bald cap to compress hair. Subjects were scanned once without helmet and oxygen mask. Then they were scanned wearing just the HGU-53/P helmet and later wearing both helmet and aircrew oxygen mask. Using the INTEGRATE editing program, unencumbered and encumbered scans could be registered by matching corresponding landmarks at the same point. The resulting image would indicate head position, relative to the helmet, necessary for a "good fit." Since these graphics could demonstrate the range of comfortable head positions for several individuals when referenced to a helmet-based axis system, they would provide designers with beneficial information about the positioning and adjustment requirements for helmet-mounted optical systems. In addition, this method of evaluating fit would furnish definitive data concerning center-of-gravity and stability of a fully encumbered head.

The topic of this paper originated from the HGU-53/P helmet survey described above. Analysis of only the unencumbered head scans was included in the evaluation project.

Discussion of Problem

During the process of collecting head scans for the HGU-53/P helmet survey, numerous data errors were observed. Most of these errors either were due to limitations of scanning equipment or were uncorrectable at the time of data collection. Many had also been observed in other surveys. General types of data error found in the scans included missing surface data, rough surface data, noncontinuity, extraneous data points, and reflected surface data.

Missing surface data occurred in various regions of the head where reflected light from the laser beam was not recorded by the scanner. For example, hair not covered by the bald cap - especially dark hair - tended to absorb most of the frequencies of light emitted by the laser and therefore did not always show up in the graphic data. In every scan, missing surface data was detected on the top of the head and beneath the chin. The surfaces of those areas were usually parallel to the horizontal base of the scanner; instead of being reflected, the laser beam proceeded in rays tangential to those surfaces. Since the scanner relied on reflected light to define data, little was recorded on the top of the head and beneath the chin. Other problematic features of the head included pupils of the eyes, nostrils, and inside the ears. Lack of reflected light also explained the missing data in these areas. Data missing behind the ears was caused primarily by obstruction of the camera's view by hair or protruding portions of the outer ear (Appendix B).

Rough surface data was another data error observed. While no particular instance of this phenomenon was discovered during data collection for the HGU-53/P helmet survey, extreme cases had been discovered in previous surveys. In these cases, the cranial and facial surfaces appeared grainy rather than smooth (Appendix C).

A third type of error was noncontinuity of surface data. Subject movement during scanning accounted for this common occurrence. In many instances, a seam was noticed along the longitude at which scanning began and ended. Such a seam resulted from an abrupt difference in radii recorded at that same longitude - ordinarily a shorter radius at the beginning than at the end (Appendix D).

The next type of data error consisted of extraneous data points. Errors of this type appeared as points or spikes projected from the surface of the head (Appendix E). Sources of extraneous data points included dust particles, eyelashes, and hair scanned off the surface of the head. After registering such data, the scanner sometimes interpolates extra points between the source points and points on the surface. Thus, nonexistent features appeared in the graphic interpretation of scan data.

Reflected surface data comprised yet another category of error. In a previous survey on the HGU-55/P helmet, an overabundance of ambient light interfered with the scanning process. The excess light read by the scanner caused it to miscalculate radial data. As a result, entire sections of data were defined to have radii much larger than in actuality, and graphic representation of scans showed distorted images of heads for which a few regions, augmented in size, were disconnected from adjacent features.

❖ ❖ ❖

Because all scans in the HGU-53/P survey were observed to contain at least one form of the data errors described above, a thorough evaluation of each scan was deemed imperative to decide which scans if any consisted of data reliable enough to be incorporated into future anthropometry studies. But how does one quantitatively assess the quality of such data? No complete evaluation of any three-dimensional anthropometrical survey had ever before been executed; therefore, no procedure had been established on how to conduct a scan evaluation based on quantifiable terms.

The only solution was to devise such a scheme from scratch and then test it through an initial evaluation of head scans from the HGU-53/P helmet survey. The development of an evaluation process would not only detail the quality of the survey's scans but also resolve a second issue regarding the correction of data errors. Once evaluations were completed, they could be used to determine which scans could be enhanced through computer editing of graphical data. Improving the quality of mediocre scans would expand the pool of scans acceptable for use in future projects. For these reasons, designing an evaluation format was an essential project undertaken to create a valuable tool.

Methodology

Before any evaluation procedure could be completed, certain parameters and criteria for evaluation had to be established. Previous investigators had cited the five types of data errors outlined in the "Discussion of Problem" as the main areas of concern. They had also listed the forehead, eyes, nose, chin, cheeks, ears, top of head, and back of head as the principal features to be evaluated. A draft scan evaluation form had been designed into a gridlined chart with these parameters in mind, using the following observation ratings: for each combination of anatomical feature and data error type, 0 indicated no occurrence of error; 1 denoted error slightly present; 2, moderately present; 3, largely present; 4, excessively present. These criteria would then determine the overall scan index: 1 for excellent; 2 for average; 3 for poor. The form also contained a block for comments. However, preliminary evaluation of randomly selected scans from the HGU-53/P survey detected specific inadequacies in this form. Evaluators found that features specified above did not define the entire surface of the scan. The mouth, left of head (subject's left), and right of head (subject's right) regions were added as features while the ear region was divided into left ear and right ear. All of the regions were designated as either facial features or cranial features so that these two categories could have separate scan indexes. Also, the observation rating of 4 was found unnecessary and was eliminated. From these analyses a new scan evaluation form was devised (Appendix F). Another preliminary evaluation of selected scans was conducted, using the new form. No more revisions were deemed necessary.

Defining the parameters and criteria was the next step. Data errors were defined as summarized in the "Discussion of Problem." Feature regions were characterized by both graphic illustration (Appendix G) and written description (Appendix H) based on anatomical landmarks widely used in anthropometry. Differentiation between observation ratings had been noted in preliminary evaluations, which would now serve as references.

Evaluation procedure developed gradually during evaluation of the HGU-53/P survey. After loading a scan file in the INTEGRATE editing program, the sequence of commands and steps were as follows:

1. SURFACE ON.
2. WIREFRAME OFF.
3. ROTATE 0 70 so that subject faces approximately forward (degree varies from subject to subject, depending on location of seam); note whether eyes and mouth are open or closed.
4. TRIM 0 0 0 -40 to remove suspension apparatus (latitude varies with spatial location of subject relative to scanner's cameras).
5. RECOLOR 0 128 (adjustment for brightness may be necessary); note again whether eyes and mouth are open or closed; note if subject has facial hair, like mustache; inspect facial features for obvious data errors, especially reflected surface data.
6. TOP; inspect for signs of reflected surface data; rotate subject until line from center of head to tip of nose appears parallel to Z-axis and lines connecting foremost visible points of ears are parallel to X-axis; move subject until Z-axis intersects tip of nose and X-axis intersects foremost visible points of ears.
7. BACK; inspect for signs of reflected surface data; note if any hair is missing.
8. LEFT; inspect cranium, ear, and cheek for reflected surface data.
9. RIGHT; inspect cranial surface, ear, and cheek for reflected surface data.
10. FRONT; move subject along Y-axis until X-axis intersects tragion landmarks.
11. SHADE.
12. PICK ON; inspect forehead, eyes, nose, and mouth for all types of data error.
13. EYE 0 -400 500; inspect chin for all types of data error.
14. TOP; inspect for all types of data error.
15. WALLS 698 701; inspect top again for noncontinuity; WALLS FULL.
16. BACK; inspect for all types of data error.
17. LEFT; inspect cranial surface and cheek for all types of data error; inspect ear for rough surface data and noncontinuity.
18. RIGHT; inspect cranial surface and cheek for all types of data error; inspect ear for rough surface data and noncontinuity.
19. RECOLOR 0 128; inspect ear again for rough surface data.

20. LEFT; inspect ear again for rough surface data.
21. SHADE; rotate subject to inspect ear for missing surface data.
22. ROTATE 0 -40 from left view; TRIM 0 -420 (varies for each subject) to isolate spikes on or behind ear.
23. RIGHT; rotate subject to inspect ear for missing surface data.
24. ROTATE 0 40 from right view; TRIM 380 (varies for each subject) to isolate spikes on or behind ear.
25. DELETE subject.

During evaluation of scans, periodically switching between wireframe mode and surface mode helped to detect rough surfaces and extraneous data points. Details of errors and all peculiarities were noted under the "Comments" heading.

In general, the severity of a data error was directly related to the size and number of occurrences, and a higher observation rating meant poorer scan quality. For example, the larger the hole in the top of the head, the higher the observation rating recorded for missing surface data; the wider the radial difference at the seam, the higher the observation rating for noncontinuity; or the more spikes on the head, the higher the observation rating for extraneous data points. Observation ratings for missing surface data more often reflected relative size rather than absolute size since head size varied among subjects. A subject with more than a slight hole in the chin would receive a moderate observation rating of 2 if the missing data covered an area no greater than half the surface of the chin. In other instances, however, the rating also depended on the location of error. Missing data of a given size in noncrucial areas - hair, eyebrows, pupils, nostrils, in or behind ears - would not be considered as severe as error on other surfaces that might prevent its use in future projects or studies.

In order to verify that consistency of evaluation was maintained, a random sampling of nine scans were re-evaluated for comparison to the original evaluations. This repeatability study was necessary to assure that a quantitative evaluation was indeed possible and validate the purpose for this project.

Results

Evaluation of the HGU-53/P scans yielded some surprising results. Many anticipated errors were found in the survey, but other anomalies appeared unexpectedly. Although missing data often occurred in the top of the head, under the chin, in hair, and around the pupils, nostrils, and ears, error under the chin was relatively minor for some scans. Extraneous data points were more commonly detected behind the ears than at any other location. In several scans, ripples became visible on the surface when shaded. For many scans, shading also revealed a ridge left of the nose. The more severe cases of this rough surface data could also be seen in wireframe mode. Some unusual errors involving the eyes had not been foreseen. One subject had one eye open and one eye closed. Another subject's eyes appeared closed when the scan was shaded; however, in color, his eyes appeared partially open. In addition, three scans could not be evaluated because they could not be located. Instead of 185 individual head scans, the HGU-53/P survey actually contained only 182.

Differences in scans from the various geographical locations were remarkable. The first scans in the survey, collected at Griffiss Air Force Base, were understandably of poorer quality than later scans. The main problem was poor resolution, resulting in a grainier appearance of the surface of the head. In general, resolution improved significantly in later scans from Eglin Air Force Base, Hurlburt Field, and Shaw Air Force Base although occasional scans exhibited the same grainy quality. At Hurlburt, another problem arose: several scans showed gaps in data. Large longitudinal sections were simply missing from cranial surfaces. A gap appearing in shade mode corresponded with a similar gap in color mode at a displacement of about twenty degrees longitude. A few spikes projected from the edges of these gaps. Large electrical equipment used simultaneously may have caused the errors.

In the repeatability study, two out of nine scans re-evaluated were scored exactly the same as their original evaluations; six were scored very nearly the same as their originals. Most deviated by one point in each of one or two observation ratings. The ninth re-evaluated scan, rated least similarly to its original, was the tenth scan rated in the initial evaluation. It deviated by one point in each of nine observation ratings.

Conclusions

The objectives of this project were successfully accomplished within a timeframe of about five to six weeks. The design and testing of an evaluation form and an evaluation procedure has proven that the quality of three-dimensional anthropometric data can be assessed in quantitative terms. The repeatability study has demonstrated that an experienced evaluator can consistently apply this evaluation procedure and achieve reliable results. While a few scans exhibit errors too severe to fully correct, the majority of the head scans in the HGU-53/P survey can be significantly improved through data editing techniques still in development. The upgraded scans may then be available for use in future anthropometric studies.

Just as important, this evaluation procedure will form the basis of future scan evaluation projects, and scan evaluations from the HGU-53/P survey will become a guide for future evaluators to follow.

References

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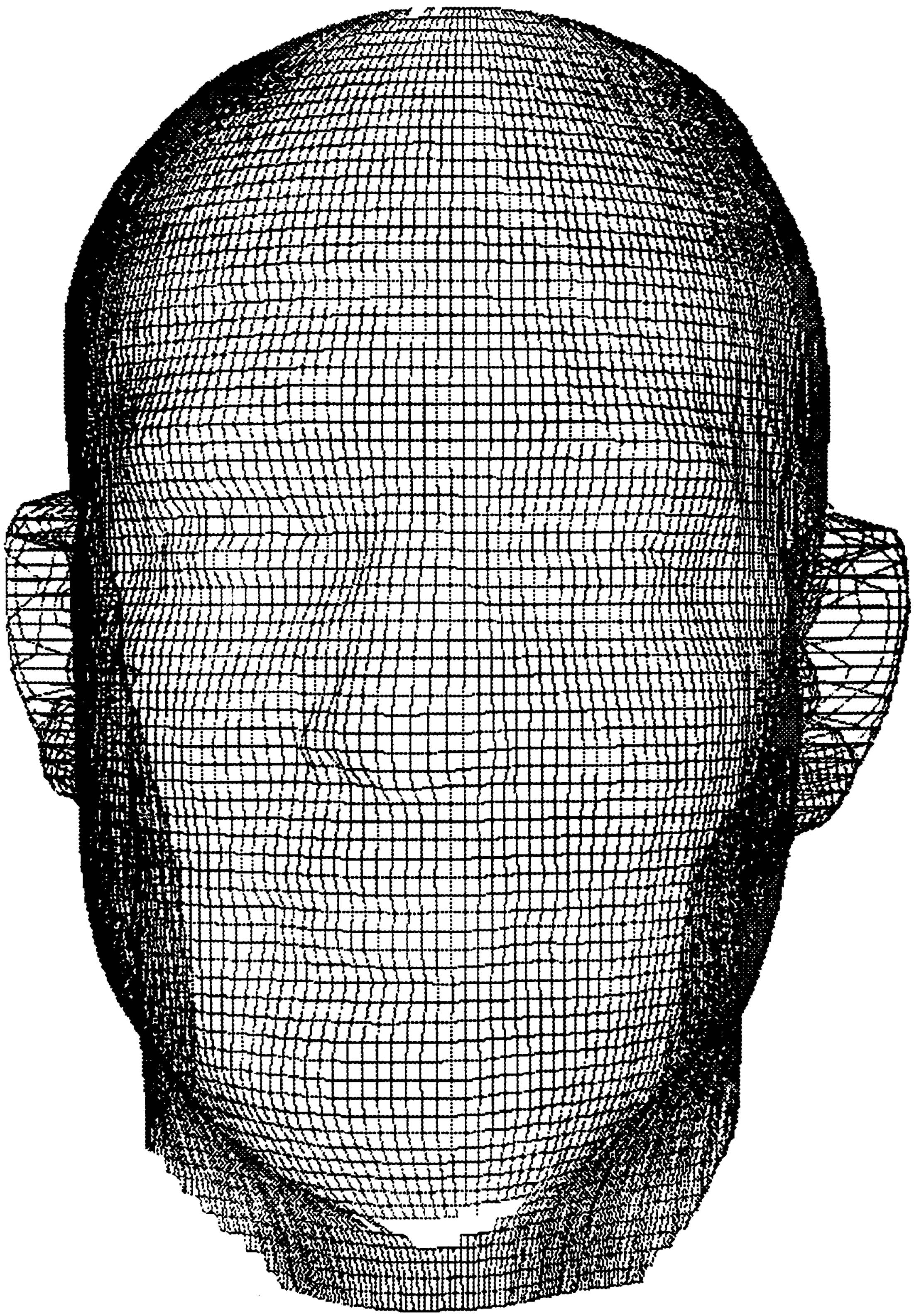
Appendix A

Wireframe Mode (PICK ON)



Appendix B

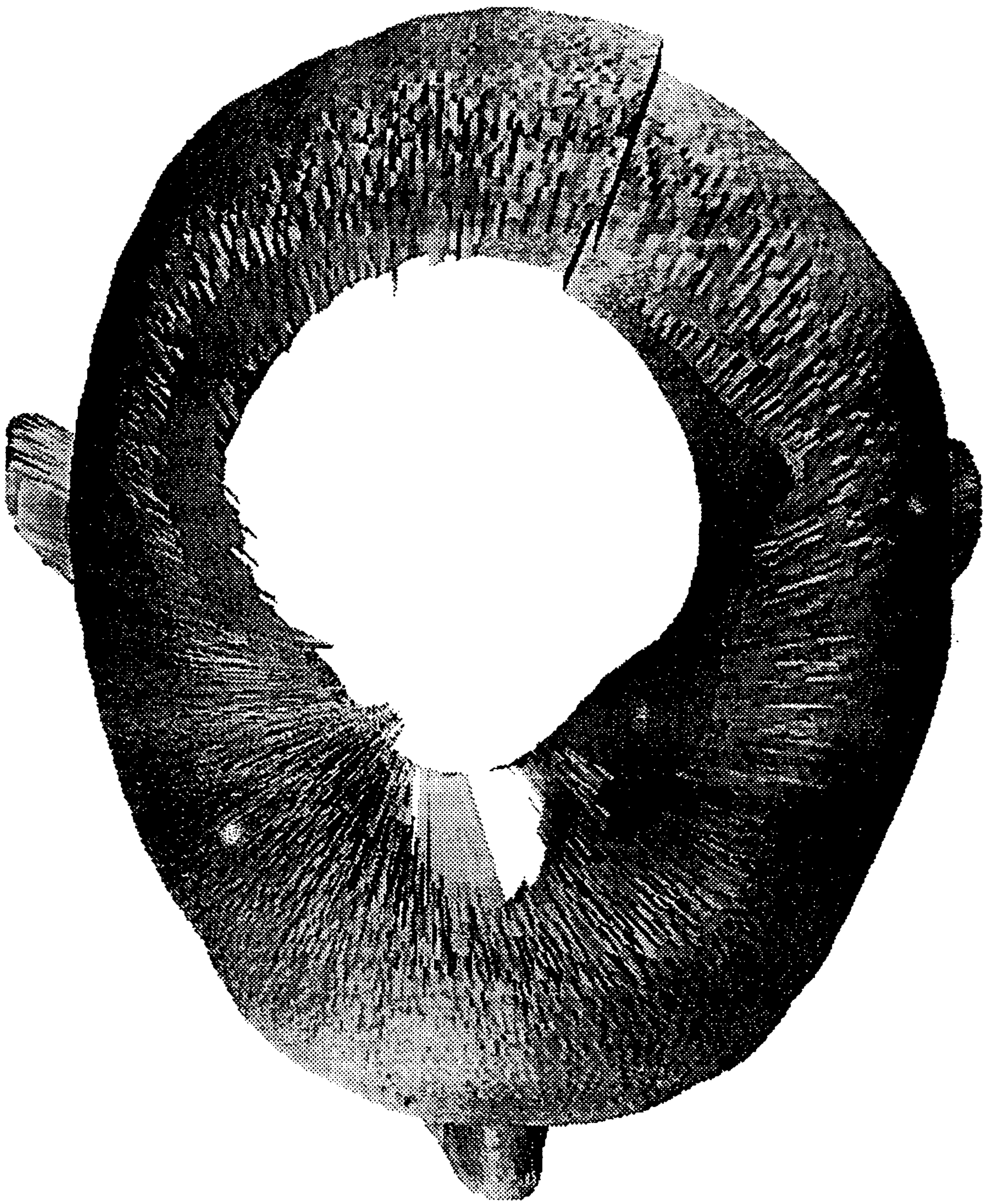
Missing Data in Surface Mode (PICK ON)

Appendix C

Rough Surface Data

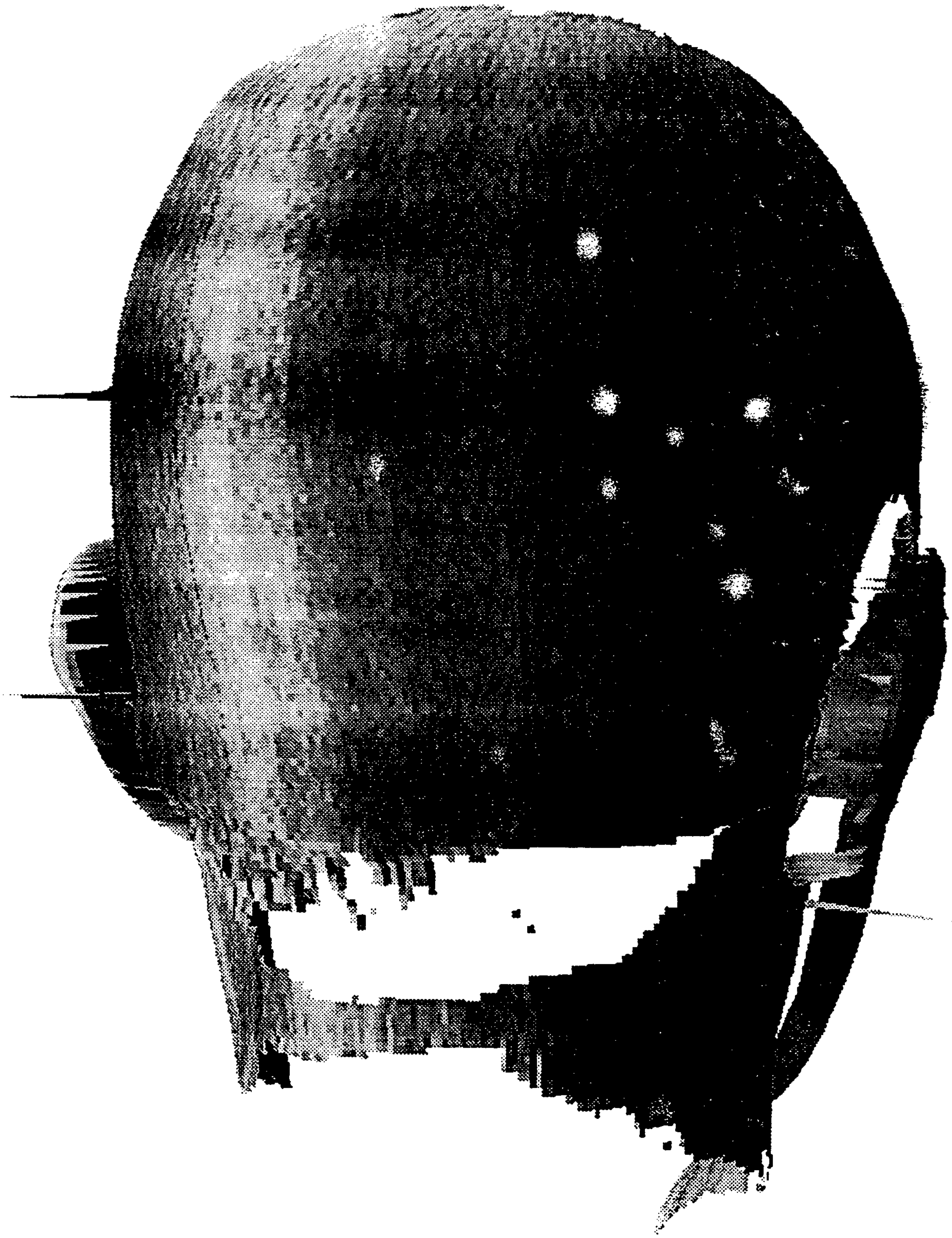
Appendix D

Noncontinuity



Appendix E

Extraneous Data Points - Spikes (PICK ON)



SCAN EVALUATION

SCAN INDEX: 1 EXCELLENT
2 AVERAGE
3 POOR

OBSERVATION RATING: 0 NO OCCURRENCE
1 SLIGHTLY PRESENT
2 MODERATELY PRESENT
3 LARGELY PRESENT

SUBJECT NUMBER: DATE: LOCATION:	FACIAL FEATURES								CRANIAL FEATURES				COMMENTS	
	FOREHEAD	EYES	NOSE	CHEEKS	MOUTH	CHIN	EARS		TOP	BACK	LEFT	RIGHT		
							LEFT	RIGHT					EYES OPEN / CLOSED	MOUTH OPEN / CLOSED
MISSING SURFACE POINTS														
ROUGH SURFACE POINTS														
NONCONTINUITY (Subject Movement)														
EXTRANEOUS DATA POINTS (Spikes)														
REFLECTED SURFACE DATA														
SCAN INDEX														

SUBJECT NUMBER: DATE: LOCATION:	FACIAL FEATURES								CRANIAL FEATURES				COMMENTS	
	FOREHEAD	EYES	NOSE	CHEEKS	MOUTH	CHIN	EARS		TOP	BACK	LEFT	RIGHT		
							LEFT	RIGHT					EYES OPEN / CLOSED	MOUTH OPEN / CLOSED
MISSING SURFACE POINTS														
ROUGH SURFACE POINTS														
NONCONTINUITY (Subject Movement)														
EXTRANEOUS DATA POINTS (Spikes)														
REFLECTED SURFACE DATA														
SCAN INDEX														

SUBJECT NUMBER: DATE: LOCATION:	FACIAL FEATURES								CRANIAL FEATURES				COMMENTS	
	FOREHEAD	EYES	NOSE	CHEEKS	MOUTH	CHIN	EARS		TOP	BACK	LEFT	RIGHT		
							LEFT	RIGHT					EYES OPEN / CLOSED	MOUTH OPEN / CLOSED
MISSING SURFACE POINTS														
ROUGH SURFACE POINTS														
NONCONTINUITY (Subject Movement)														
EXTRANEOUS DATA POINTS (Spikes)														
REFLECTED SURFACE DATA														
SCAN INDEX														

Appendix G

Scan Evaluation Regions

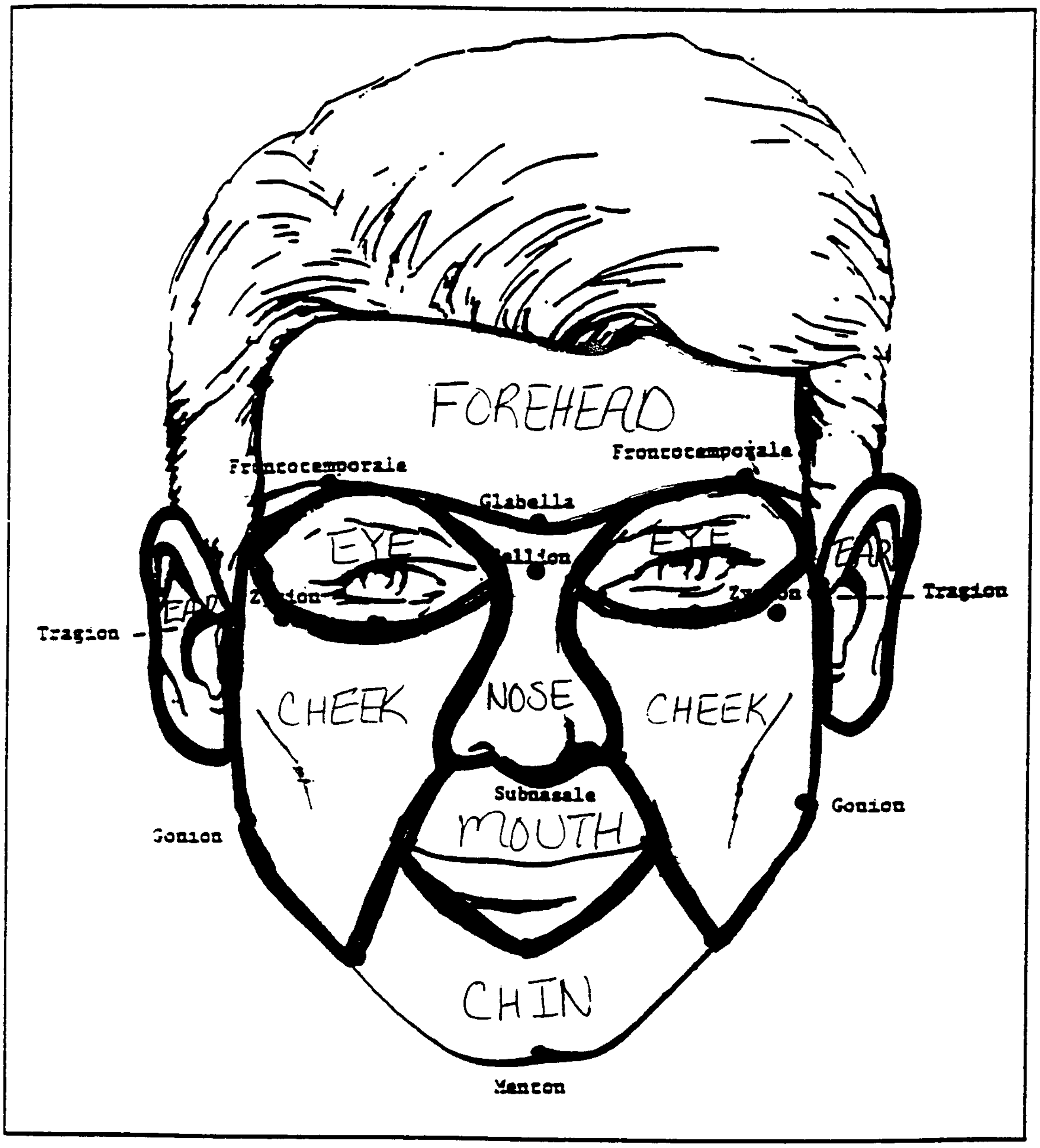


FIGURE 5

The Marked Anthropometric Landmarks

Appendix H

SCAN EVALUATION REGIONS

FACIAL FEATURES

FOREHEAD - Bounded by line from glabella, along right browridge through right frontotemporale to right ectocanthus, toward right ear approximately at right tragion, along hairline or bald cap edge (possibly alternately, whichever limits boundary of forehead more) toward left ear approximately at left tragion to left ectocanthus, along browridge through left frontotemporale back to glabella.

EYES - Bounded from endocanthus to ectocanthus by browridge and lower edge of bony eye socket.

NOSE - Bounded by line from glabella to browridges, down along visible edges of nose to subnasale.

CHEEKS - Bounded by line from endocanthus, along lower edge of bony eye socket to ectocanthus, toward ear approximately at tragion, along jawbone through gonion to midlateral infra-mandibular (MIM), toward nose through chelion to outer corner of nose, up along visible edge of nose back to endocanthus.

MOUTH - Bounded by line from subnasale to right outer corner of nose, down to right chelion, curving through supramenton to left chelion, up to left outer corner of nose, back to subnasale.

CHIN - Bounded by line from supramenton to right chelion, down to right MIM, along jawbone to right gonion, across jugular region along submandibular to left gonion, along jawbone to left MIM, up to left chelion, back to supramenton.

EARS - Bounded by line from tragion around area where cranial surface intersects with outer ear; including portion of outer ear protruding from cranial surface.

CRANIAL FEATURES

TOP - Composed of cranial surface visible when TOP command entered for front-centered head scan in Integrate.

BACK - Composed of cranial surface visible when BACK command entered for front-centered head scan in Integrate.

LEFT - Composed of cranial surface visible when LEFT command entered for front-centered head scan in Integrate.

RIGHT - Composed of cranial surface visible when RIGHT command entered for front-centered head scan in Integrate.

CONCENTRATIONS OF RADIONUCLIDES

Clayton Ciomperlik
High School Apprenticeship Program
AL/OEBA
Brooks AFB TX

August 1994

Base page #7

CONCENTRATIONS OF RADIONUCLIDES

Clayton Ciomperlik
High School student
Al/OEBA
Brooks AFB

ABSTRACT

It is finally being realized that our most valuable resource is being destroyed. Many issues have been brought forth on the extent of damage being done to the environment. I have decided to determine the amount of damage done by this long term abuse of our environment. Over a period of 2 weeks the lab personnel and I studied the concentrations of radionuclides in soil within a 5 mile radius of my house. I took 3 types of samples: water samples, soil samples, and a radon canister. These samples will enhance my knowledge of environmental science and give me an overview of the radionuclides which occur naturally in the earth. Based on concentrations there was no evidence that there was long term destruction of the earth.

INTRODUCTION

With the help of my section, OEBA, I initiated a study over various parts of my town, St. Hedwig. This project was especially designed to help me understand the process involved in working with potentially dangerous samples, to determine the radionuclides that occur naturally and in what concentration, and compare these values with the expected concentrations. We ran tests on 11 samples taken randomly to find radioactive nuclides. These samples include a radon canister, 7 soil samples, and 3 water samples. These samples did not only provide much needed information; they helped me to understand the process used to prepare and test samples for radioactivity.

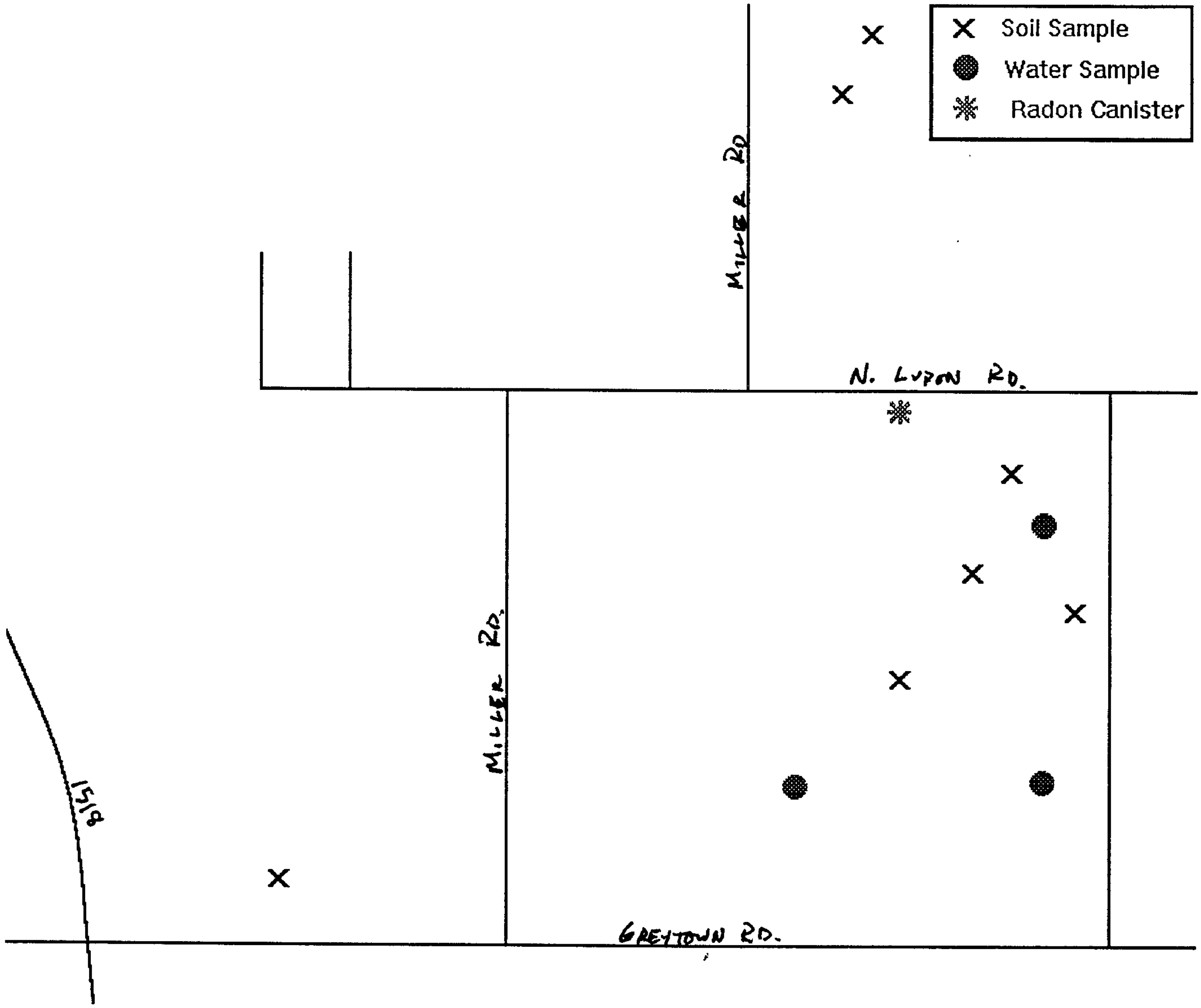
METHODS FOR SOIL, WATER, AND RADON SAMPLES

I began my project by taking a few samples from St. Hedwig, Texas. My soil samples were taken from approximately the top six inches of soil. This dirt, which weighed approximately 5000 grams, was put into a twelve by twelve inch plastic bag. When the collection of my soil samples was finished I began to collect my water samples. The previous day I took home water jugs in which I would collect the water samples in. In these jugs I was sure to collect at least 1000 milliliters of water for analysis. The radon canister I picked up the previous day was opened and placed in the living area of my home where exposed to ambient concentrations of Rn-222 for a seven day period.

PREPARATION AND ANALYSIS

Upon arriving at the laboratory these samples were each given sample numbers. The soil and water samples would each need alpha, beta, and gamma tests run. The soils were put into baking pans and baked for a minimum of 24 hours. After being baked for almost 2 days the soils were put into a shaker where they were the clumps would be broken over a time period of 20 to 30 minutes. 860 milliliters of this dirt was then placed in a marinelli, sealed, counted for gamma emissions and analyzed via gamma spectroscopy. Another gram of this dirt was then placed in a sifter and 1 gram of the dirt was placed onto a planchet. This dirt was analyzed for gross alpha/beta emission using gas flow proportional counter technology. The water consisted of a completely different process. Nitric acid was added to the water. 860 milliliters of water was then separated, again put into a marinelli, and counted for gamma emissions and analyzed via gamma spectroscopy. 200 milliliters was then put onto a planchet and was evaporated at approximately 110 degrees. These planchets were analyzed for gross alpha/beta emmision using gas flow proportional counter technology. After a 1 week time period the radon canister was taken out of my house and brought in for analysis. All specimen numbers and sample types were entered into the G5000 series Alpha/Beta/Gamma counter analysis program. After the set up proceedure, the analyzers counted the number of alpha/beta particles and gamma rays in each sample per 60 minute count time.

ST. HEDWIG TX
BEXAR COUNTY



I have included a map to give an idea of exactly where my samples were taken to give a better idea of the distance apart and the location ~~to a fuller extent.~~

TAB SAMPLE RESULTS

SAMPLE #	SAMPLE TYPE	GROSS ALPHA	GROSS BETA	Ra 226	U 238	Th 232	Rn-222
19402844	Water (pCi/L)	1.1 +/- 0.8 pCi/L	11.9 +/- 2.6 pCi/L	< MDA	<MDA	<MDA	
19402845	Water "	<1.61 pCi/L	15.08 +/- 2.46 pCi/L	<MDA	<MDA	<MDA	
19402846	Water "	4.7 +/- 2.2 pCi/L	27.6 +/-2.1 pCi/L	0.8 +/- 0.5	<MDA	<MDA	
19402847	Soil (pCi/gm)	<0.6	<3.7	<MDA	0.06 +/- 0.03	1.0 +/- 0.03	
19402848	Soil "	2.6 +/- 1.9	32.7 +/- 2.2	<MDA	0.07 +/- 0.01	0.6 +/- 0.02	
19402849	Soil "	6.8 +/- 2.5	25.1 +/- 2.0	<MDA	0.09 +/- .01	0.8 +/- 0.03	
19402850	Soil "	4.2 +/- 2.1	25.5 +/- 2.0	0.7 +/- 0.5	0.05 +/- 0.03	1.0 +/- 0.03	
19402851	Soil "	7.2 +/- 2.6	25.7 +/- 2.0	0.7 +/- 0.5	0.07 +/- 0.03	0.09 +/- 0.03	
19402852	Soil "	5.5 +/- 2.4	29.2 +/- 2.1	<MDA	0.09 +/- 0.01	0.9 +/- 0.03	
19402853	Soil "	6.7 +/- 2.5	28.5 +/- 2.1	<MDA	0.07 +/- 0.01	0.75 +/- 0.03	
19403100	Radon pCi/L	~~[illegible]~~					1.3 ± 0.6
TX Avg.				0.54 - 1.4 pCi/gm	.48 - 1.5 pCi/gm	.40 - 1.1 pCi/gm	
U.S. Avg.				.23 - 4.2 "	0.12 -3.8 "	.10 - 3.4 "	

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Radon Detection and Measurement Second Edition, Glenn F. Knoll, Copywright 1989, John Wiley & Sons, Inc., Michigan.

SAMPLE ANALYSIS RESULTS REPORTED ON 05-aug-1994
ARMSTRONG LABORATORY
OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
RADIOANALYTICAL FUNCTION (OEBSA)
BROOKS AIR FORCE BASE, TEXAS 78235-5000

OE ID

19402844

AL/OEBSA
BLDG 140
2402 E DRIVE
BROOKS AFB TX 78235-5114

BASE ADDRESS CODE: Q00111C

IDENTIFICATION:
Base Sample #: GN942504 SCHOOL PROJECT (CLAYTON)
OEHL ID: 19402844
Type of Sample: WATER, NONPOTABLE, NOT SDWA
Workplace or Site ID: 00111 ____ ____ AL/OE BLDG 140,, TX
Date Collected: 18-JUL-94
Date Received: 20-JUL-94
Date Completed: 04-AUG-94

CESIUM 134	< 11.3	PICOCURIES PER LITER
CESIUM 137	< 12.6	PICOCURIES PER LITER
CHROMIUM 51	< 94.5	PICOCURIES PER LITER
COBALT 60	< 13.6	PICOCURIES PER LITER
EUROPIUM 152	< 35.5	PICOCURIES PER LITER
EUROPIUM 154	< 21.2	PICOCURIES PER LITER
GROSS ALPHA	< 0.6	PICOCURIES PER LITER
GROSS BETA	< 3.7	PICOCURIES PER LITER
NIOBIUM 95	< 11.9	PICOCURIES PER LITER
RUTHENIUM 103	< 10.8	PICOCURIES PER LITER
RUTHENIUM 106	< 103.8	PICOCURIES PER LITER
ZIRCONIUM 95	< 20.1	PICOCURIES PER LITER

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
ERROR TERM AT 95% CONFIDENCE LEVEL.

MR. AMON J. CLAY, GM-13
Chief, Radioanalytical Branch, BAFB
DSN 240-2061

SAMPLE ANALYSIS RESULTS REPORTED ON 05-aug-1994
ARMSTRONG LABORATORY
OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
RADIOANALYTICAL FUNCTION (OEBSA)
BROOKS AIR FORCE BASE, TEXAS 78235-5000

OE ID

19402845

AL/OEBSA
BLDG 140
2402 E DRIVE
BROOKS AFB TX 78235-5114

BASE ADDRESS CODE: Q00111C

IDENTIFICATION:
Base Sample #: GN942505 SCHOOL PROJECT (CLAYTON)
OEHL ID: 19402845
Type of Sample: WATER, NONPOTABLE, NOT SDWA
Workplace or Site ID: 00111 ____ ____ AL/OE BLDG 140,, TX
Date Collected: 18-JUL-94
Date Received: 20-JUL-94
Date Completed: 04-AUG-94

CESIUM 134	<	12.			PICOCURIES PER LITER
CESIUM 136	<	13.6			PICOCURIES PER LITER
CHROMIUM 51	<	104.2			PICOCURIES PER LITER
COBALT 60	<	14.7			PICOCURIES PER LITER
EUROPIUM 152	<	35.5			PICOCURIES PER LITER
EUROPIUM 154	<	23.			PICOCURIES PER LITER
GROSS ALPHA		1.1	+/-	0.8	PICOCURIES PER LITER
GROSS BETA		11.9	+/-	2.6	PICOCURIES PER LITER
NIOBIUM 95	<	12.3			PICOCURIES PER LITER
RUTHENIUM 103	<	11.8			PICOCURIES PER LITER
RUTHENIUM 106	<	123.6			PICOCURIES PER LITER
ZIRCONIUM 95	<	20.6			PICOCURIES PER LITER

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
ERROR TERM AT 95% CONFIDENCE LEVEL.

MR. AMON J. CLAY, GM-13
Chief, Radioanalytical Branch, BAFB
DSN 240-2061

SAMPLE ANALYSIS RESULTS REPORTED ON 05-aug-1994
ARMSTRONG LABORATORY
OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
RADIOANALYTICAL FUNCTION (OEBSA)
BROOKS AIR FORCE BASE, TEXAS 78235-5000

OE ID

19402846

AL/OEBSA
BLDG 140
2402 E DRIVE
BROOKS AFB TX 78235-5114

BASE ADDRESS CODE: Q00111C

IDENTIFICATION:
Base Sample #: GN942506 SCHOOL PROJECT (CLAYTON)
OEHL ID: 19402846
Type of Sample: WATER, NONPOTABLE, NOT SDWA
Workplace or Site ID: 00111 ____ ____ AL/OE BLDG 140,, TX
Date Collected: 18-JUL-94
Date Received: 20-JUL-94
Date Completed: 04-AUG-94

CESIUM 134	<	9.6			PICOCURIES PER LITER
CESIUM 137	<	10.7			PICOCURIES PER LITER
CHROMIUM 51	<	77.5			PICOCURIES PER LITER
COBALT 60	<	12.6			PICOCURIES PER LITER
EUROPIUM 152	<	27.5			PICOCURIES PER LITER
EUROPIUM 154	<	17.4			PICOCURIES PER LITER
GROSS ALPHA	<	1.61			PICOCURIES PER LITER
GROSS BETA		15.08	+/-	2.46	PICOCURIES PER LITER
NIOBIUM 95	<	10.			PICOCURIES PER LITER
RUTHENIUM 103	<	9.7			PICOCURIES PER LITER
RUTHENIUM 106	<	92.4			PICOCURIES PER LITER
ZIRCONIUM 95	<	17.6			PICOCURIES PER LITER

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
ERROR TERM AT 95% CONFIDENCE LEVEL.

MR. AMON J. CLAY, GM-13
Chief, Radioanalytical Branch, BAFB
DSN 240-2061

SAMPLE ANALYSIS RESULTS REPORTED ON 05-aug-1994
ARMSTRONG LABORATORY
OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
RADIOANALYTICAL FUNCTION (OEBSA)
BROOKS AIR FORCE BASE, TEXAS 78235-5000

OE ID

19402847

AL/OEBSA
BLDG 140
2402 E DRIVE
BROOKS AFB TX 78235-5114

BASE ADDRESS CODE: Q00111C

IDENTIFICATION:
Base Sample #: GS942497 SCHOOL PROJECT (CLAYTON)
OEHL ID: 19402847
Type of Sample: SOIL
Workplace or Site ID: 00111 ____ ____ AL/OE BLDG 140,, TX
Date Collected: 18-JUL-94
Date Received: 20-JUL-94
Date Completed: 04-AUG-94

SAMPLE WEIGHT 3791.2 GRAMS DRY.

CESIUM 134	<	0.02			PICOCURIES PER GRAM DRIED
CESIUM 137		0.02	+/-	0.01	PICOCURIES PER GRAM DRIED
COBALT 60	<	0.03			PICOCURIES PER GRAM DRIED
GROSS ALPHA		4.7	+/-	2.2	PICOCURIES PER GRAM DRIED
GROSS BETA		27.6	+/-	2.1	PICOCURIES PER GRAM DRIED
POTASSIUM 40		14.6	+/-	0.8	PICOCURIES PER GRAM DRIED
RADIUM 226		0.8	+/-	0.5	PICOCURIES PER GRAM DRIED
THORIUM 232		1.	+/-	0.03	PICOCURIES PER GRAM DRIED
THORIUM 234		0.4	+/-	0.1	PICOCURIES PER GRAM DRIED
URANIUM 235		0.06	+/-	0.03	PICOCURIES PER GRAM DRIED

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
ERROR TERM AT 95% CONFIDENCE LEVEL.

MR. AMON J. CLAY, GM-13
Chief, Radioanalytical Branch, BAFB
DSN 240-2061

SAMPLE ANALYSIS RESULTS REPORTED ON 05-aug-1994
ARMSTRONG LABORATORY
OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
RADIOANALYTICAL FUNCTION (OEBSA)
BROOKS AIR FORCE BASE, TEXAS 78235-5000

OE ID

19402848

AL/OEBSA
BLDG 140
2402 E DRIVE
BROOKS AFB TX 78235-5114

BASE ADDRESS CODE: Q00111C

IDENTIFICATION:
Base Sample #: GS942498 SCHOOL PROJECT (CLAYTON)
OEHL ID: 19402848
Type of Sample: SOIL
Workplace or Site ID: 00111 ____ ____ AL/OE BLDG 140,, TX
Date Collected: 18-JUL-94
Date Received: 20-JUL-94
Date Completed: 04-AUG-94

SAMPLE WEIGHT 4306.5 GRAMS DRY.

CESIUM 134	<	0.02			PICOCURIES PER GRAM DRIED
CESIUM 137		0.2	+/-	0.01	PICOCURIES PER GRAM DRIED
COBALT 60	<	0.02			PICOCURIES PER GRAM DRIED
GROSS ALPHA		2.6	+/-	1.9	PICOCURIES PER GRAM DRIED
GROSS BETA		32.7	+/-	2.2	PICOCURIES PER GRAM DRIED
POTASSIUM 40		18.	+/-	1.	PICOCURIES PER GRAM DRIED
RADIUM 226	<	0.5			PICOCURIES PER GRAM DRIED
THORIUM 232		0.6	+/-	0.02	PICOCURIES PER GRAM DRIED
THORIUM 234		0.3	+/-	0.09	PICOCURIES PER GRAM DRIED
URANIUM 235		0.07	+/-	0.01	PICOCURIES PER GRAM DRIED

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
ERROR TERM AT 95% CONFIDENCE LEVEL.

MR. AMON J. CLAY, GM-13
Chief, Radioanalytical Branch, BAFB
DSN 240-2061

SAMPLE ANALYSIS RESULTS REPORTED ON 05-aug-1994
ARMSTRONG LABORATORY
OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
RADIOANALYTICAL FUNCTION (OEBSA)
BROOKS AIR FORCE BASE, TEXAS 78235-5000

OE ID

19402849

AL/OEBSA
BLDG 140
2402 E DRIVE
BROOKS AFB TX 78235-5114

BASE ADDRESS CODE: Q00111C

IDENTIFICATION:
Base Sample #: GS942499 SCHOOL PROJECT (CLAYTON)
OEHL ID: 19402849
Type of Sample: SOIL
Workplace or Site ID: 00111 ____ ____ AL/OE BLDG 140,, TX
Date Collected: 18-JUL-94
Date Received: 20-JUL-94
Date Completed: 04-AUG-94

SAMPLE WEIGHT 4909.9 GRAMS DRY.

CESIUM 134	<	0.2			PICOCURIES PER GRAM DRIED
CESIUM 137		0.09	+/-	0.01	PICOCURIES PER GRAM DRIED
COBALT 60	<	0.2			PICOCURIES PER GRAM DRIED
GROSS ALPHA		6.8	+/-	2.5	PICOCURIES PER GRAM DRIED
GROSS BETA		25.1	+/-	2.	PICOCURIES PER GRAM DRIED
POTASSIUM 40		11.6	+/-	0.7	PICOCURIES PER GRAM DRIED
RADIUM 226	<	0.5			PICOCURIES PER GRAM DRIED
THORIUM 232		0.8	+/-	0.03	PICOCURIES PER GRAM DRIED
THORIUM 234		0.2	+/-	0.09	PICOCURIES PER GRAM DRIED
URANIUM 235		0.09	+/-	0.01	PICOCURIES PER GRAM DRIED

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
ERROR TERM AT 95% CONFIDENCE LEVEL.

MR. AMON J. CLAY, GM-13
Chief, Radioanalytical Branch, BAFB
DSN 240-2061

SAMPLE ANALYSIS RESULTS REPORTED ON 05-aug-1994
ARMSTRONG LABORATORY
OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
RADIOANALYTICAL FUNCTION (OEBSA)
BROOKS AIR FORCE BASE, TEXAS 78235-5000

OE ID

19402850

AL/OEBSA
BLDG 140
2402 E DRIVE
BROOKS AFB TX 78235-5114

BASE ADDRESS CODE: Q00111C

IDENTIFICATION:
Base Sample #: GS942500 SCHOOL PROJECT (CLAYTON)
OEHL ID: 19402850
Type of Sample: SOIL
Workplace or Site ID: 00111 ____ ____ AL/OE BLDG 140,, TX
Date Collected: 18-JUL-94
Date Received: 20-JUL-94
Date Completed: 04-AUG-94

SAMPLE WEIGHT 4979.6 GRAMS DRY.

CESIUM 134	<	0.02			PICOCURIES PER GRAM DRIED
CESIUM 137		0.09	+/-	0.01	PICOCURIES PER GRAM DRIED
COBALT 60	<	0.02			PICOCURIES PER GRAM DRIED
GROSS ALPHA		4.2	+/-	2.1	PICOCURIES PER GRAM DRIED
GROSS BETA		25.5	+/-	2.	PICOCURIES PER GRAM DRIED
POTASSIUM 40		12.8	+/-	0.7	PICOCURIES PER GRAM DRIED
RADIUM 226		0.7	+/-	0.5	PICOCURIES PER GRAM DRIED
THORIUM 232		1.	+/-	0.03	PICOCURIES PER GRAM DRIED
THORIUM 234		0.3	+/-	0.1	PICOCURIES PER GRAM DRIED
URANIUM 235		0.05	+/-	0.03	PICOCURIES PER GRAM DRIED

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
ERROR TERM AT 95% CONFIDENCE LEVEL.

MR. AMON J. CLAY, GM-13
Chief, Radioanalytical Branch, BAFB
DSN 240-2061

SAMPLE ANALYSIS RESULTS REPORTED ON 05-aug-1994
ARMSTRONG LABORATORY
OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
RADIOANALYTICAL FUNCTION (OEBSA)
BROOKS AIR FORCE BASE, TEXAS 78235-5000

OE ID

19402851

AL/OEBSA
BLDG 140
2402 E DRIVE
BROOKS AFB TX 78235-5114

BASE ADDRESS CODE: Q00111C

IDENTIFICATION:
Base Sample #: GS942501 SCHOOL PROJECT (CLAYTON)
OEHL ID: 19402851
Type of Sample: SOIL
Workplace or Site ID: 00111 ____ ____ AL/OE BLDG 140,, TX
Date Collected: 18-JUL-94
Date Received: 20-JUL-94
Date Completed: 04-AUG-94

SAMPLE WEIGHT 5184.7 GRAMS DRY.

CESIUM 134	<	0.02			PICOCURIES PER GRAM DRIED
CESIUM 137		0.03	+/-	0.01	PICOCURIES PER GRAM DRIED
COBALT 60	<	0.2			PICOCURIES PER GRAM DRIED
GROSS ALPHA		7.2	+/-	2.6	PICOCURIES PER GRAM DRIED
GROSS BETA		25.7	+/-	2.	PICOCURIES PER GRAM DRIED
POTASSIUM 40		12.	+/-	0.7	PICOCURIES PER GRAM DRIED
RADIUM 226		0.7	+/-	0.5	PICOCURIES PER GRAM DRIED
THORIUM 232		0.9	+/-	0.03	PICOCURIES PER GRAM DRIED
THORIUM 234		0.3	+/-	0.1	PICOCURIES PER GRAM DRIED
URANIUM 235		0.07	+/-	0.03	PICOCURIES PER GRAM DRIED

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
ERROR TERM AT 95% CONFIDENCE LEVEL.

MR. AMON J. CLAY, GM-13
Chief, Radioanalytical Branch, BAFB
DSN 240-2061

SAMPLE ANALYSIS RESULTS REPORTED ON 05-aug-1994
ARMSTRONG LABORATORY
OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
RADIOANALYTICAL FUNCTION (OEBSA)
BROOKS AIR FORCE BASE, TEXAS 78235-5000

OE ID

19402852

AL/OEBSA
BLDG 140
2402 E DRIVE
BROOKS AFB TX 78235-5114

BASE ADDRESS CODE: Q00111C

IDENTIFICATION:
Base Sample #: GS942502 SCHOOL PROJECT (CLAYTON)
OEHL ID: 19402852
Type of Sample: SOIL
Workplace or Site ID: 00111 ____ ____ AL/OE BLDG 140,, TX
Date Collected: 18-JUL-94
Date Received: 20-JUL-94
Date Completed: 04-AUG-94

SAMPLE WEIGHT 6305.9 GRAMS DRY.

CESIUM 134	<	0.02			PICOCURIES PER GRAM DRIED
CESIUM 137		0.1	+/-	0.01	PICOCURIES PER GRAM DRIED
COBALT 60	<	0.02			PICOCURIES PER GRAM DRIED
GROSS ALPHA		5.5	+/-	2.4	PICOCURIES PER GRAM DRIED
GROSS BETA		29.2	+/-	2.1	PICOCURIES PER GRAM DRIED
POTASSIUM 40		15.	+/-	0.9	PICOCURIES PER GRAM DRIED
RADIUM 226	<	0.5			PICOCURIES PER GRAM DRIED
THORIUM 232		0.9	+/-	0.03	PICOCURIES PER GRAM DRIED
THORIUM 234		0.3	+/-	0.01	PICOCURIES PER GRAM DRIED
URANIUM 235		0.09	+/-	0.01	PICOCURIES PER GRAM DRIED

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
ERROR TERM AT 95% CONFIDENCE LEVEL.

MR. AMON J. CLAY, GM-13
Chief, Radioanalytical Branch, BAFB
DSN 240-2061

SAMPLE ANALYSIS RESULTS REPORTED ON 05-aug-1994
ARMSTRONG LABORATORY
OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
RADIOANALYTICAL FUNCTION (OEBSA)
BROOKS AIR FORCE BASE, TEXAS 78235-5000

OE ID

19402853

AL/OEBSA
BLDG 140
2402 E DRIVE
BROOKS AFB TX 78235-5114

BASE ADDRESS CODE: Q00111C

IDENTIFICATION:
Base Sample #: GS942503 SCHOOL PROJECT (CLAYTON)
OEHL ID: 19402853
Type of Sample: SOIL
Workplace or Site ID: 00111 ____ ____ AL/OE BLDG 140,, TX
Date Collected: 18-JUL-94
Date Received: 20-JUL-94
Date Completed: 04-AUG-94

SAMPLE WEIGHT 4791.3 GRAMS DRY.

CESIUM 134	<	0.02			PICOCURIES PER GRAM DRIED
CESIUM 137		0.3	+/-	0.01	PICOCURIES PER GRAM DRIED
COBALT 60	<	0.02			PICOCURIES PER GRAM DRIED
GROSS ALPHA		6.7	+/-	2.5	PICOCURIES PER GRAM DRIED
GROSS BETA		28.5	+/-	2.1	PICOCURIES PER GRAM DRIED
POTASSIUM 40		14.9	+/-	0.9	PICOCURIES PER GRAM DRIED
RADIUM 226	<	0.5			PICOCURIES PER GRAM DRIED
THORIUM 232		0.7	+/-	0.03	PICOCURIES PER GRAM DRIED
THORIUM 234		0.09	+/-	0.08	PICOCURIES PER GRAM DRIED
URANIUM 235		0.07	+/-	0.01	PICOCURIES PER GRAM DRIED

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
ERROR TERM AT 95% CONFIDENCE LEVEL.

MR. AMON J. CLAY, GM-13
Chief, Radioanalytical Branch, BAFB
DSN 240-2061

SAMPLE ANALYSIS RESULTS REPORTED ON 05-aug-1994
ARMSTRONG LABORATORY
OCCUPATIONAL AND ENVIRONMENTAL HEALTH DIRECTORATE
RADIOANALYTICAL FUNCTION (OEBSA)
BROOKS AIR FORCE BASE, TEXAS 78235-5000

OE ID

19403100

AL/OEBSA
BLDG 140
2402 E DRIVE
BROOKS AFB TX 78235-5114

BASE ADDRESS CODE: Q00111C

IDENTIFICATION:
Base Sample #: OX942496 START: 940718 1800 SCH PROJECT (CLAYTON)
OEHL ID: 19403100
Type of Sample: ACTIVATED CHARCOAL
Workplace or Site ID: 00111 ____ ____ AL/OE BLDG 140,, TX
Date Collected: 25-JUL-94 Time Collected: 1830
Date Received: 01-AUG-94
Date Completed: 04-AUG-94

RADON 222	1.3	+/-	0.6	PICOCURIES PER LITER

RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.
ERROR TERM AT 95% CONFIDENCE LEVEL.

MR. AMON J. CLAY, GM-13
Chief, Radioanalytical Branch, BAFB
DSN 240-2061

ANALYSIS OF VARIOUS SAMPLES FOR THE PRESENCE OF METALS

Kara L. Ciomperlik

East Central High School
7173 FM 1628
San Antonio, Texas 78263

Final Report for:
High School Apprenticeship Program
Armstrong Laboratory

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, DC

and

Armstrong Laboratory

August 1994

ANALYSIS OF VARIOUS SAMPLES FOR THE PRESENCE OF METALS

Kara L. Ciomperlik
East Central High School

ABSTRACT

The main function of the Metals Section of the Armstrong Laboratory is to provide support for bases worldwide in the analysis of environmental and occupational samples for metal content. These samples include, but are not limited to, drinking water, wastewater, soils, sludges, biologicals, and air samples. The section analyzes an average of 10,000 samples per year with the average of four or five different analyses. The sample load is almost evenly split between occupational and environmental samples. Analysis of the sample is accomplished by using several varieties of spectroscopic instruments including Inductively Coupled Plasma (ICP). Flame Atomic Absorption (FAA), Graphite Furnace Atomic Absorption (GFAA), and Flow Injection Mercury System (FIMS). This section also manually prepares samples for mercury analysis.

ANALYSIS OF VARIOUS SAMPLES FOR THE PRESENCE OF METALS

Kara L. Ciomperlik

INTRODUCTION

The Armstrong Laboratory Metals Section is an EPA compliance laboratory. The section must maintain certification through several national programs including EPA, NIOSH, OSHA, and the College of American Pathologists (CAP), as well as environmental certification from a number of states who run their own programs. The section does EPA compliance analyses which means that it helps bases comply with EPA guidelines by identifying problem areas through the analysis of drinking water, wastewater, soils, sludges, and biologicals. It also does air analysis that is monitored by NIOSH and OSHA. The program is quality controlled by both EPA and NIOSH as the section performs analysis of samples from both of these agencies. Also, the CAP monitors the analysis of the biological samples being tested for lead. In addition the section is also monitored by individual state agencies, some of which have stricter guidelines than EPA.

The Metals Section has also been involved in many special projects. One such project was the analysis of the blood of children at a local day-care for possible lead-poisoning. The blood samples are run as zinc protoporphryins as a screen. These samples are then analyzed for lead content on a Zeeman Furnace. The Metals Section was also the main contributor to the Lead Assessment Program. This program identifies and monitors drinking water for lead contamination at bases worldwide. Soap samples are also analyzed for boron. The most recent project done was an analysis for lead in paint. The metals section also completed 120 priority samples. Each sample was completed within a week.

METHODOLOGY

In order to be EPA certified, the Metals Section must use EPA methods to perform these analyses. NIOSH also requires appointed methods. Some examples of EPA methods that the sections use are: (1) 200 series methods for both potable and non-potable water, (1a) a specific method, 239.2 which is used for lead analysis through a Perkin Elmer Zeeman Furnace Atomic Absorption Spectrophotometer, (2) SW846 methods for wastewater and solid materials including paint, wipes, soil, etc., (2a) also a specific method, SW246 method 6010 is used for analysis on an Inductively Coupled Plasma Emission Spectrophotometer. Prior to analysis, samples must be digested using appropriate Sample Preparation Methods (e.g. Method 3005-3050), (3) NIOSH methods are used for air and biological analysis, (3a) one specific method, NIOSH 8003, is used on the analysis of lead in blood.

APPARATUS

All of the analyses are processed using advanced electronic equipment. This equipment is operated by the principle of detection of light absorption of light emission. The range of equipment consists of three general categories of spectrophotometers: (1) Flame Atomic Absorption, (2) Graphite Furnace Atomic Absorption, and (3) Inductively Coupled Plasma.

The Flame Atomic Absorption Spectrophotometer (FAA) introduces a liquid sample into an air-acetylene flame. A hollow cathode lamp containing the metal of interest is lit and gives off light at a wavelength characteristic of that metal. If the sample contains that metal, it absorbs the light at that wavelength, and is compared to a set of standards to obtain a concentration in micrograms per liter. The FAA can detect common metals, including the alkali and alkaline earths, as well as several transition metals such as iron, magnesium, copper, and manganese. The Graphite

Furnace Atomic Absorption Spectrophotometer (GFAA) is the same principle, but only microliter amounts of the sample are used, and the sample is subjected to programmed heating and is much more sensitive than the FAA. There are several advantages to using the GFAA rather than the FAA. One is that the GFAA has a higher sensitivity than the FAA. Another is the ability of the GFAA to handle small sample volumes of liquids. Also, the GFAA has the ability to analyze solid samples directly without pretreatment. Finally, the GFAA has a lower noise level than the FAA. The GFAA is capable of detecting a wide variety of metals such as arsenic, antimony, selenium, tin, and thallium.

The Inductively Coupled Plasma Emission Spectrophotometer (ICP) measures element-emitted light by optical spectrometry. The sample absorbs energy in the form of heat and the resulting aerosol is transported to the plasma torch. The light emitted is at a wavelength characteristic of that metal. The amount of light emitted is compared to the standards.

NETWORK APPLICATIONS

Joseph A. Croswell

Mosley High School
501 Mosley Drive
Lynn Haven, FL 32444

Final Report for:
High School Apprenticeship Program
Air Force Civil Engineering Support Agency

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, DC

and

Air Force Civil Engineering Support Agency

August 1994

NETWORK APPLICATIONS

Joseph A. Croswell
Mosley High School

Abstract

The decision of whether to put software applications on the network or on the individual computers' hard drives was studied. Different orientations were examined, and more questions were found than answers. The question of how many users needed the application became important. Other areas that were considered were performance, administration, and economics. It was determined that each application and each network should be considered separately according to speed, administration time, and money.

NETWORK APPLICATIONS

Joseph A. Croswell

Introduction

As bigger networks start to appear in more small offices as well as in large corporations, the question of how to administer networks becomes more and more important. This project centered on one aspect of this administration, where to put applications. Applications placed on the network may cause a decline in performance of the network and the individual workstation by using too much bandwidth, while applications placed on individual systems are harder to maintain because updates have to be administered on each individual computer rather than in one central location (the server). With the rise of networking and the client-server network this is one of the many pressing questions that are surfacing.

Discussion of Problem

There are many things to be considered when starting a computer network. How much speed and therefore what type of network infrastructure does the network you're building need? What type of cable is necessary? How fast does the server need to be? What type of operating system is the server going to run on? Which network operating system (NOS) should be used? What companies should you buy the network cards, hubs, servers, etc. from? What type of management utilities are you going to need to administer the network? The possibilities are endless. This project was primarily concerned with the question of where to place the applications. Should the applications be located on the network side (the server) or on the client side (the individual workstations)? This question must be answered when starting a new client-server network.

Client-server networks are networks of personal workstation computers connected to powerful computers called servers. Servers serve multiple functions. They provide a large amount of disk space, which is shared by all users, and high speed processing, which is necessary to handle the multiple users that will be logging onto the system. Servers also provide a means to connect all the users together. Users are people who use the personal workstations to connect to the servers. Workstations are the individual computers that each client uses to reach the network, communicate with other users, and accomplish tasks.

The three aspects of client-server application placement that were considered in this project are the performance of the network and the individual workstations, the amount of administration, and the economics and total cost of each of the possibilities. Performance includes the overall speed of the network and the waiting time the end users experiences while trying to use the applications. This involves the amount of bandwidth needed to transfer information and the time the server has to spend executing programs and applications. Administration includes the difficulty of managing and updating a network. Economics deals with the overall price of the applications and the administration needed for them. The cost of the applications is based on where they are located.

Methodology

A variety of methods were used in this project. A common method was to question network administrators at Air Force Civil Engineering Support Agency. These administrators originally set up the network, and are very familiar with it Many tests were performed at the agency, but we did not have two networks to thoroughly test the possibilities and make comparisons on. Because of the many variables involved in networks and networking no exact data could be determined from these tests, but much could be obtained from the data.

Results

When this project was initially started, it was thought that there would be one answer. The applications would either be put on the server, or on the client. However, it was found that each application has to be considered differently.

Conclusions

We found that each application has to be considered individually in terms of cost, manageability, and performance aspects. Each network installation is different, and therefore has its own needs and limitations.

The performance of the application on the network has to be considered. Small programs that don't use very much bandwidth can easily be put on the network if many different users need them. Large programs have to be looked at closer because of their bandwidth consumption. Questions such as how they will effect the speed of the network as a whole, how many users will need the program, and how fast the users will need the programs to run have to be considered when adding larger programs to the network. Programs that always use the network or other networks will obviously have to go through the network at some time and take up network bandwidth and therefore should be placed on to the server in most cases. Only when the program is very large and very few users are going to use it should it be put on the individual workstations. Although these applications should be put on the server in most cases, access to these resources should be limited by the administrators, so that the network does not become bogged down with traffic. This is also a question based on the capabilities of the network. If the network is limited by disk space, then large applications would have to be put on the client side. Also some networks are inherently faster than others because of the hardware used, so the performance issue has to be evaluated for each site.

Administration is another concern. If most of the applications are on the server, updates and problem solving are made much easier because there is one individual location to change and modify applications and look for problems. Plus many application specific causes for problems can be eliminated if only one user on the network is having problems. The problem is obviously outside of the application if another user is not experiencing any problems running the same application from the same place on the network. If all the users are having problems with the same application then it is obvious that the problem lies on the network side, not the individual workstations. Updates are also a large problem if many applications are put on the individual workstations. One administrator could not update every computer every time any of the applications needed to be updated. More administrators would be needed to maintain the network if a lot of the applications were placed on the individual workstations. This would greatly increase the cost of managing and controlling the network. The cost of administration is also a big concern. Many sites cannot afford more than two or three administrators. With so few administrators, it would be impossible to upgrade or manage every application on every individual computer.

The cost of the applications is another concern. Buying an individual copy for each client could be very expensive. Licenses would still be needed for each client that needed access to use the application from the network, but the cost would be much less. Also many companies and individual programs offer site licenses in which the program can be used by anyone connected to the network. Another option is counters. A site could have for example only five licenses for a certain application. With a license counter, only five clients would be able to use the application at a time. This greatly decreases costs if the application is only for a few users. This also makes it easier if someone switches workstations and still needs access to the application because you do not have to move the application between hard drives. The user will have access to the application no matter what workstation the user logs in on.

Each application and each network is different. Not only does the application have to be considered, but the limits and speed of the system, the total cost for the applications, and the amount of manpower needs have to considered for each application.

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STUDY, DESIGN, AND MODIFICATION OF THE DYNAMIC CONE PENETROMETER

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Final Report for:
High School Apprentice Program
Armstrong Laboratory

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August 1994

STUDY, DESIGN, AND MODIFICATION OF THE DYNAMIC CONE PENETROMETER

Timothy O. Dickson
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Abstract

The Dynamic Cone Penetrometer is used by the U.S. Air Force to test the shearing strength of soil of unpaved runways to determine the number of aircraft that can safely take off and land. The current design is bulky and requires the use of two operators. Captain David Weintraub, in his dissertation for doctor of philosophy at the University of Florida, designed an Automated Airfield Dynamic Cone Penetrometer (AADCP). The AADCP was assembled and studied for practical application. This study determined that this version of the AADCP would be impractical for use by the U.S. Air Force. A concept for a Modified Dynamic Cone Penetrometer was proposed. Like the AADCP, it requires only one operator, but instead of using an automated hammer, the Modified Dynamic Cone Penetrometer determines the distance penetrated to eliminate the recorder.

STUDY, DESIGN, AND MODIFICATION OF THE DYNAMIC CONE PENETROMETER

Timothy O. Dickson

Introduction

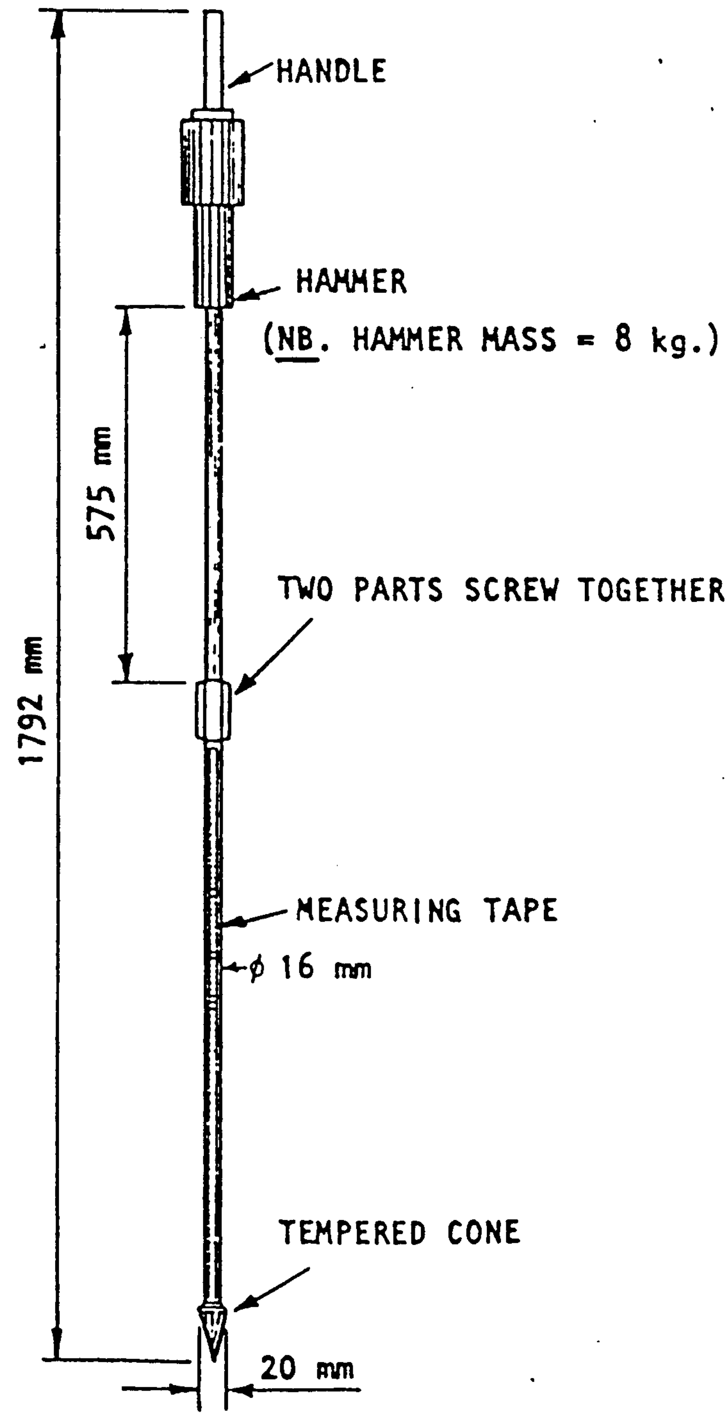
In order to land aircraft safely on unpaved runways, the United States Air Force must be able to test the shearing strength of the soil. The Dynamic Cone Penetrometer (DCP), first developed in South Africa, provides the Air Force with a reliable method of testing the shearing strength. The DCP (page 10-4) consists of an 8 kilogram hammer that drops 575 millimeters to drive a one meter penetration rod. The hammer is continuously dropped until the penetration rod completely penetrates the soil to a certain depth, depending on the specific type of DCP. After every five blows, the number of millimeters (or inches) penetrated is recorded. This value is correlated with the standard California Bearing Ratio (CBR) to determine the strength of the soil by using the formula:

$$\text{Log CBR} = 2.46 - 1.12\ (\text{Log DCP})$$

Two people operate the DCP -- one to drop the hammer, and one to record the number of blows. To reduce the labor involved in working with the DCP, Captain David Weintraub, while working on his dissertation for his degree of doctor of philosophy at the University of Florida, developed an Automated Airfield Dynamic Cone Penetrometer (AADCP). The AADCP eliminates the need to raise the hammer by hand. Research was performed at Wright Laboratory under the supervision of Edwin Duncan to determine if this version of the AADCP would be beneficial to the U.S. Air Force.

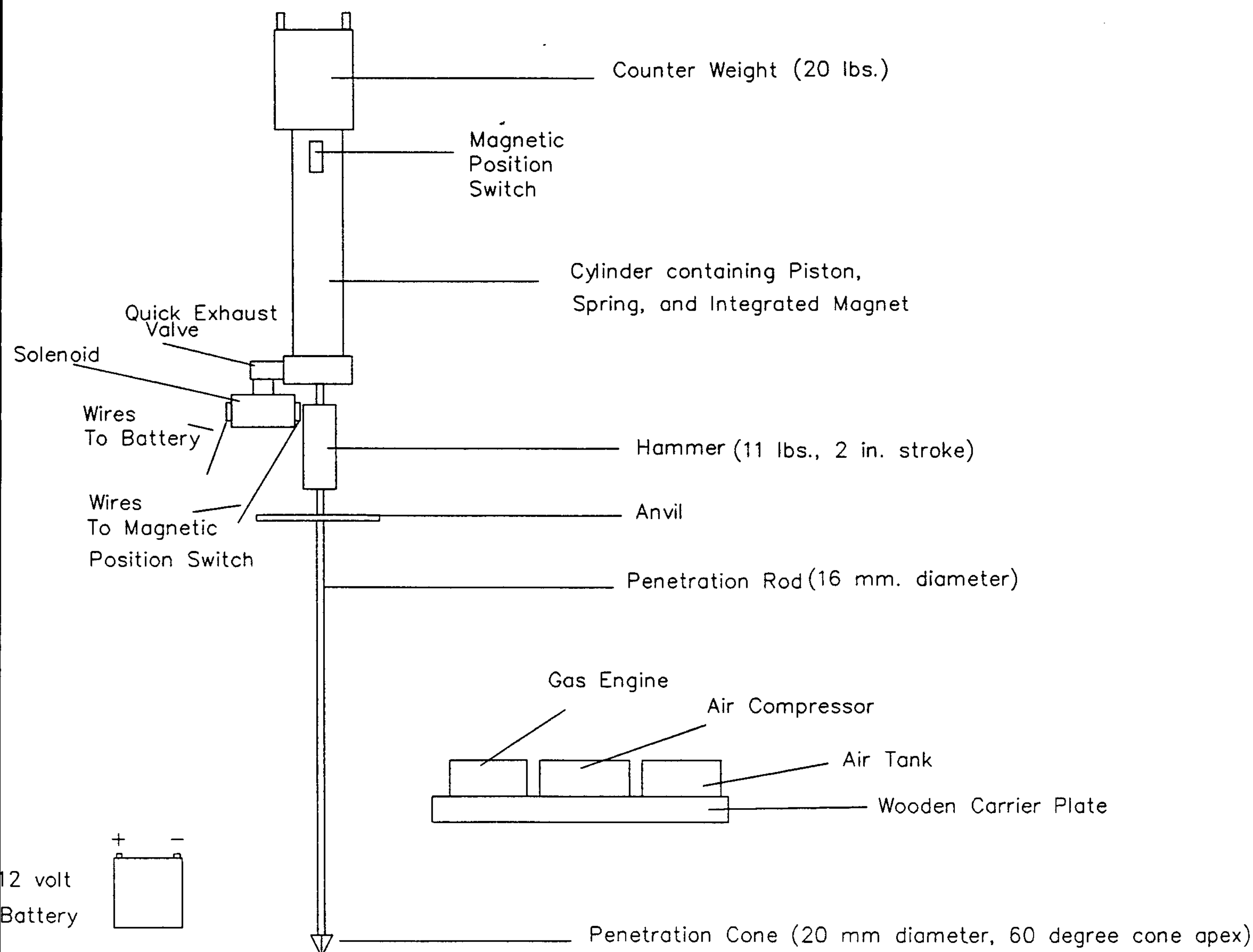
Methodology

After researching the workings of the DCP, the AADCP (page 10-5) was reassembled. Because of the complication of the wiring and the lack of adequate diagrams to explain the wiring, Captain David Weintraub was contacted to discuss the wiring of the AADCP. Captain Weintraub said there are three wires: the hot wire (red), the supply wire (green), and the ground wire (black). The hot wire from the battery was connected to the red wire from the magnetic position switch. The ground wire from the battery was connected to the black wire on the



Dynamic Cone Penetrometer

Automated Airfield Dynamic Cone Penetrometer



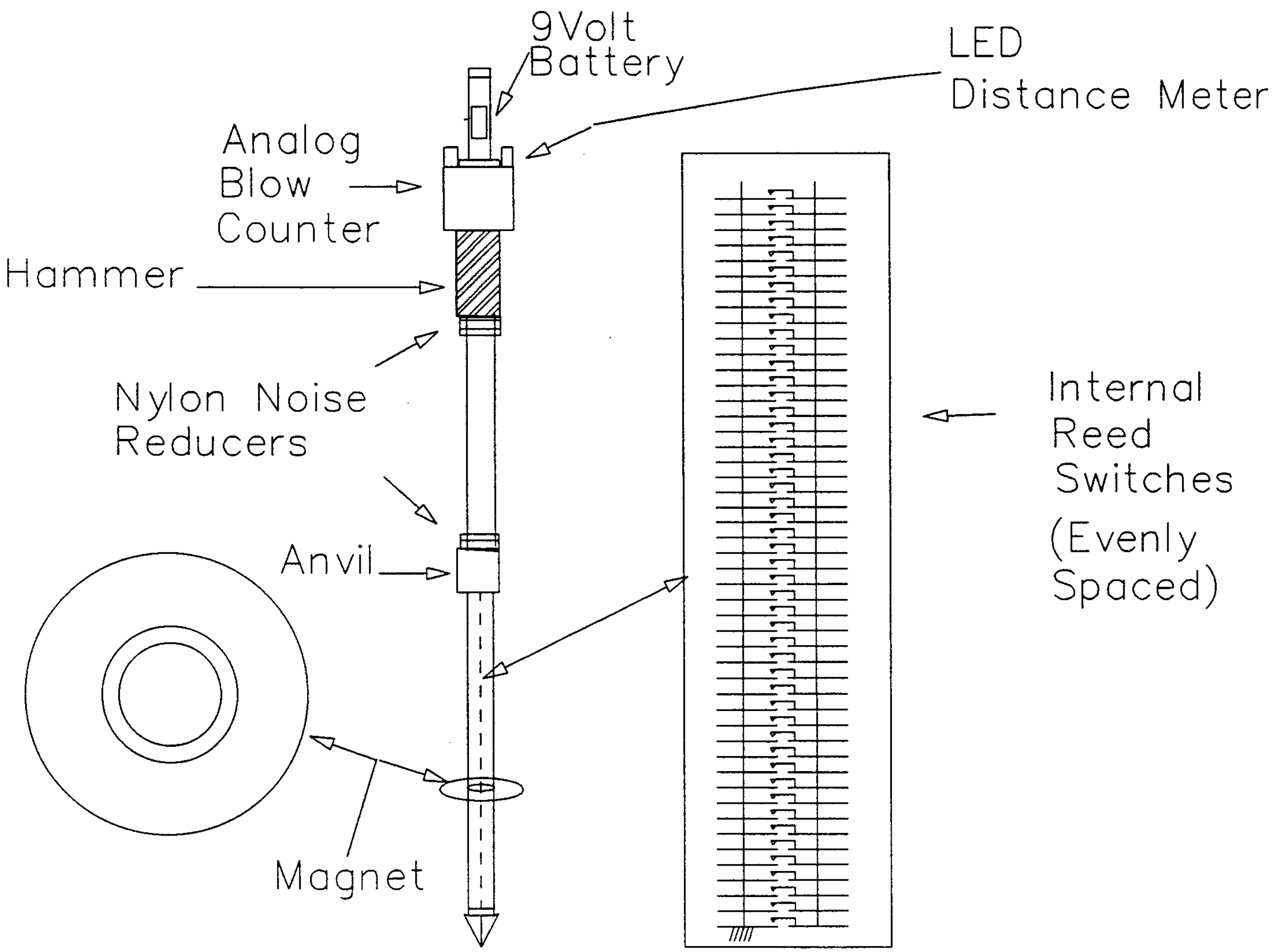
magnetic position switch. The remaining battery wire and the green wire from the magnetic position switch were both connected to the digital blow counter at the 5 to 48 volt positions. Once the AADCP is activated, an integrated magnet in the piston will activate the magnetic position switch that will send an electrical signal to the digital blow counter. This signal will cause the counter to increase by one. The power unit, including the air compressor, air tank, gas engine, and 12 volt battery, was removed from the wood carrier board and attached to an aluminum plate to lighten the load. The system works by starting the gas engine, which activates a pulley to run the air compressor, which compresses air to be stored in the air tank. Once the pressure in the air tank reaches 110 PSI, the AADCP can be activated. The air causes the piston to rise, which compresses the spring. The magnetic position switch sends a signal to the digital blow counter and causes the air to be released through the quick exhaust valve. The piston then falls and drives the penetration rod.

Results

The assembled AADCP was examined and determined in this study to be impractical for use in the U.S. Air Force. The electrical equipment and wiring make it cumbersome for the user and increase the chances of a malfunction. Wires could also become loose in the field and would be difficult to repair. An efficient DCP should be lightweight in order for paratroopers to carry for long distances, but the air compressor, air tank, gas engine, and battery add extra weight to the load. The battery must also be kept level at all times, and a battery acid spill could be dangerous. The gas engine would be troublesome to refuel in the field and could possibly be too noisy for use where stealthful tactics are necessary. The AADCP would be difficult to maintain and repair in the field because the operator must be trained in the operation of the machine and the repair of the systems. Spare parts and tools would have to be transported with the AADCP, which would increase the weight of the load.

To reduce the manpower needed in the operation of a DCP, a concept for a Modified Dynamic Cone Penetrometer (MDCP) was proposed (page 10-7). The MDCP would require the hammer to be lifted manually, but would eliminate the need for a man to measure the distance penetrated. An internal vertical terminal strip with reed switches spaced evenly at a fixed distance could be placed inside a hollow penetration rod made from 316 stainless steel. The reed switches would be activated by an external circular nylon position indicator with a circular magnet enclosed, which would rest on the ground. The penetration rod would be driven through this

Modified Dynamic Cone Penetrometer



indicator. The magnet would cause a reed switch to close, thus completing a circuit and sending an electrical impulse to a self powered digital counter to record the distance penetrated. All wiring would run through the hollow penetration rod to the distance counter. The system would run off a 9 volt battery, which would send a current through the reed switches. An analog blow counter would be placed across from the distance counter. The blow counter would be activated by a gear on the piston when it rises to its maximum height. Nylon noise reducers would be placed at the bottom of the hammer and the top of the anvil. This would prevent the MDCP from being too noisy. The anvil would allow for the penetration rod to screw into its base as on the original DCP. Wire quick disconnects would be added to separate the wire in order to disassemble the MDCP.

Conclusions

After working with the Automated Airfield Dynamic Cone Penetrometer designed by Captain David Weintraub for four weeks, it was determined that this version would be impractical for use by the U.S. Air Force. The size, weight, and complicated electrical wiring may make it too troublesome to work with in the field, and the power system could become hazardous if a gas or battery acid spill occurred. Although it would reduce the labor involved in operation, it will involve more labor to maintain and repair. The proposed Modified Dynamic Cone Penetrometer requires only one person for transportation and operation, is simpler to assemble, operate, disassemble, maintain, and repair, and is lighter.

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AN OPTIMIZATION STUDY ON A 99% PURITY MOLECULAR SIEVE OXYGEN CONCENTRATOR: EFFECTS OF PURGE ORIFICE SIZE

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AN OPTIMIZATION STUDY ON A 99% PURITY MOLECULAR SIEVE OXYGEN CONCENTRATOR: EFFECTS OF PURGE ORIFICE SIZE

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Abstract

The purpose of this work was to determine the effects of purge orifice size on the performance of a 99% purity molecular sieve oxygen concentrating system. These systems separate oxygen from compressed air through the process of pressure-swing adsorption. Several purge orifice sizes were evaluated. The study showed that an orifice size of 0.040 inches I.D. gave the highest oxygen recovery rate while the concentrator produced 99% purity oxygen. Further, the optimum inlet air pressure and cycle time for the concentrator was 35 psia and 14 seconds, respectively.

AN OPTIMIZATION STUDY ON A 99% PURITY MOLECULAR SIEVE OXYGEN CONCENTRATOR: EFFECTS OF PURGE ORIFICE SIZE

Maureen D. Finke
New Braunfels High School

Introduction

Molecular sieve oxygen concentrators (MSOCs) are used to supply breathable oxygen onboard some military aircraft. This concentrated oxygen is breathed by the aircrew to prevent hypoxia at high altitudes. In the future, oxygen concentrators will replace conventional liquid oxygen systems because they are cost-effective, safer, and increase aircraft versatility.

A MSOC separates oxygen from air by using the technique of pressure-swing adsorption. Beds or canisters filled with zeolite molecular sieve adsorb nitrogen from compressed air. This separation of oxygen and nitrogen occurs because of a difference in equilibrium adsorption capacity. Nitrogen molecules have a slight polarity and are attracted to the electrostatic fields within the crystal structure of the zeolite. Oxygen and argon are non polar and therefore, compete less effectively for zeolite adsorption sites. Current technology yields oxygen purities up to 93-95% with the remaining gas being argon and a small (<1%) percentage of nitrogen.

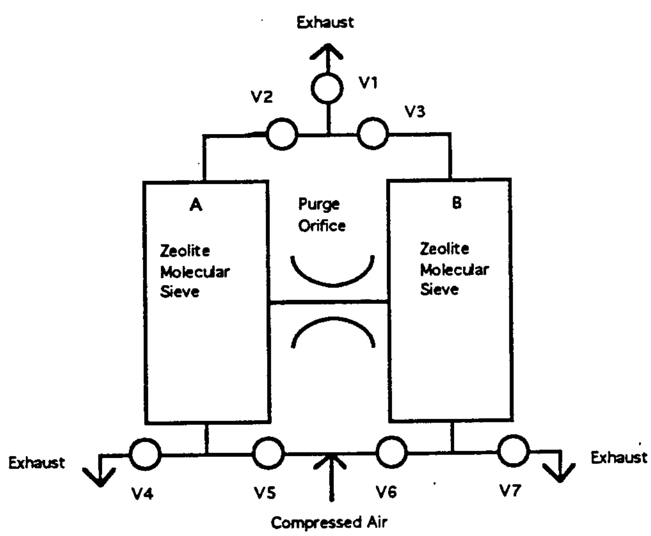

Figure 1. A Standard Molecular Sieve Oxygen Generator

A simple molecular sieve oxygen concentrator is comprised of two adsorbent beds, an orifice, several valves, and an electric timer. (Figure 1). The beds are alternately cycled through an adsorption (pressurization) stage and a desorption (depressurization) stage. During the adsorption step, compressed air enters the adsorbent beds and nitrogen is preferentially adsorbed. Product oxygen is withdrawn and some of the purified oxygen passes through the purge orifice to the opposite bed, thereby flushing the adsorbed nitrogen to the surrounding atmosphere. The pressurized bed is then vented to atmospheric pressure and purged with oxygen from the opposite bed.

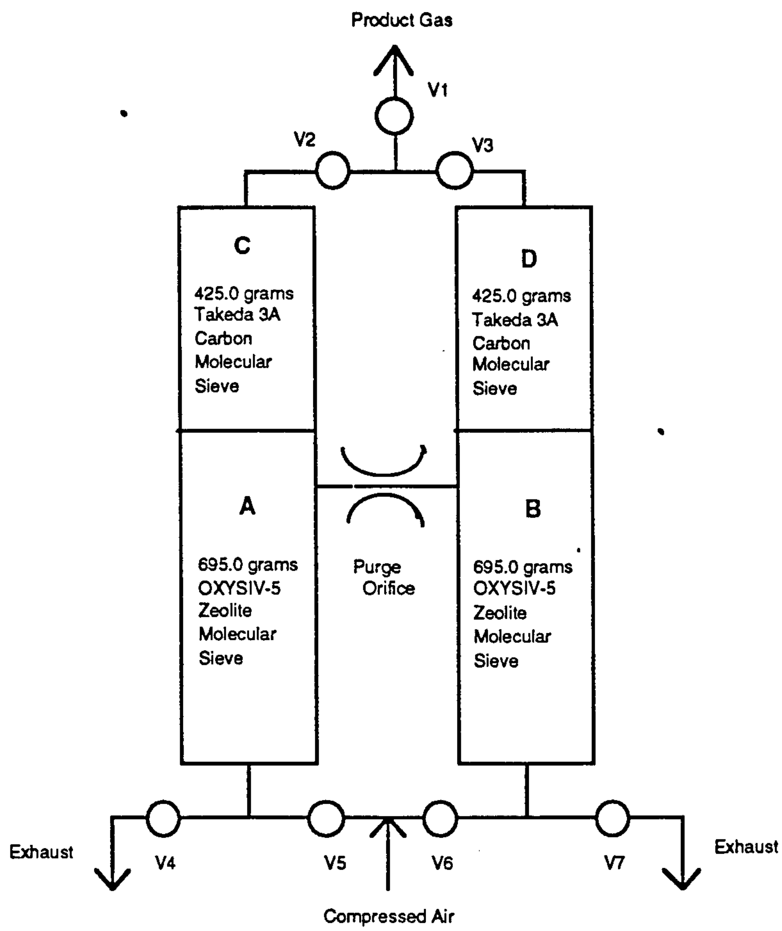

Figure 2. A Small-Scale 99% Molecular Sieve Oxygen Concentrator.

In some cases, such as during an aircraft rapid decompression or high altitude flight, a higher purity of oxygen is required. The 99% purity molecular sieve oxygen concentrator invented at the Armstrong Laboratory can produce 99.65% oxygen[1] The high purity product can be

[1] Miller G.W. and C.F. Theis, "Molecular Sieve Concentrator with Secondary Oxygen Purifier," U.S. Patent Number 4,880,443 (1989).

obtained by attaching a second adsorbent bed filled with carbon molecular sieve adsorbent in series with a zeolite bed (Figure 2). The 99% purity MSOC is similar to a standard MSOC. However, the zeolite adsorbs the nitrogen and the carbon molecular sieve adsorbs the argon, resulting in an oxygen purity of >99%. The purpose of this investigation was to determine the effects of varying purge orifice size on the oxygen recovery of a 99% molecular sieve oxygen generating system. Three purge orifices having different diameters were tested under a variety of conditions in order to identify the system conditions which maximize the production of 99% pure oxygen.

Experimental

A 99% oxygen purity MSOC with four interconnecting beds was constructed (Figure 2). Adsorbent beds of two different lengths were built from 2 inch O.D. stainless steel tubing. Beds A and B were 20 inches long and beds C and D were 15 inches long. A purge orifice was connected near the outlets of beds A and B.

Beds A and B were filled with 695.0 grams of 16X40 mesh OXYSIV-5 zeolite molecular sieve. Takeda 3A carbon molecular sieve (CMS) was loaded into beds C and D. Before loading the CMS into the beds, the CMS pellets were reduced in size from 1/8" to 10X40 mesh using a cutting mill.[2] This size reduction was the only pretreatment performed on the 425.0 grams of CMS loaded into Beds C and D.

A computer program controlled the cycle times and recorded the data. The valves were activated every half-cycle. For example, a half-cycle time would activate valves 2, 5, and 7 open for 7 seconds and close valves 3, 4, and 6 for 7 seconds. During the next half-cycle, the valves reverse positions. Therefore, one cycle consists of pressurizing and depressurizing an adsorbent bed. The data-acquisition program recorded the oxygen, nitrogen, and argon concentrations (%), inlet air flow (SLPM), and product flow rate (SLPM). The inlet air pressure was controlled with a pressure regulator. The product flow was adjusted manually using a valve.

In to determine the maximum oxygen recovery at purities >99%, it was necessary to test the system under a sufficient number of varying conditions. The apparatus was tested with three different purge orifices having diameters of 0.028, 0.040, and 0.055 inches

[2] Miller, G.W. and C.F. Theis, "A 99% Purity Molecular Sieve Oxygen Concentrator, " SAFE Journal, 20, 1, 6, (1990).

I.D. Inlet pressures of 35, 45, and 55 psia were used. The device was operated at cycle times of 10, 12, 14, and 16 seconds. The product flow rates that were tested were 0.50, 0.75, 1.00, and 1.50 SLPM. The system was operated at 144 different conditions.

Results

Data analysis was based on determining the test condition that resulted in the highest oxygen recovery at 99% oxygen or better. In Table 1, the oxygen recovery at an inlet pressure of 35 psia reached a maximum of 4.9% using an orifice size of 0.040 inches I.D. Figures 3-11 show that the highest oxygen recovery was attained at a cycle time of 14 seconds, an inlet pressure of 35 psia, purge orifice diameter of 0.040 inches, and a product flow of 0.75 SLPM. Highest oxygen recovery obtained was 4.9%.

Table 1. Highest Oxygen Recoveries Oxygen Purities of >99.0%

Orifice I.D. (inches)	Inlet Pressure (psia)	Cycle Time (seconds)	Product Flow (SLPM)	O2 Recovery (%)
0.028	35	14	0.75	4.4
0.028	45	14	0.75	3.445
0.028	55	12	0.75	2.8832
0.040	35	14	0.75	[4.8683]
0.040	45	12	0.75	3.25
0.040	55	10	0.50	1.6393
0.055	35	12	0.75	3.8076
0.055	45	12	0.75	3.1481
0.055	55	--	---	----

[] Highest Oxygen Recovery

-- Oxygen Concentration below 99%.

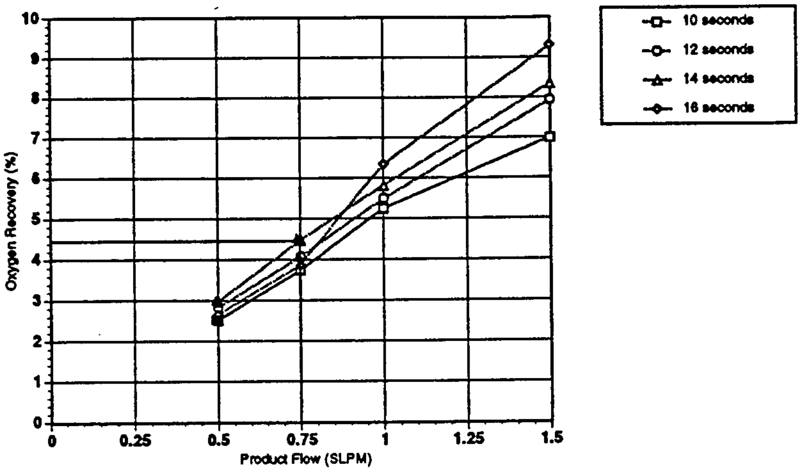

Figure 3. Oxygen Recoveries of a MSOC with a purge orifice of 0.028 inches I.D at 35 psia. (Shaded symbols are those that had over 99% pure oxygen)

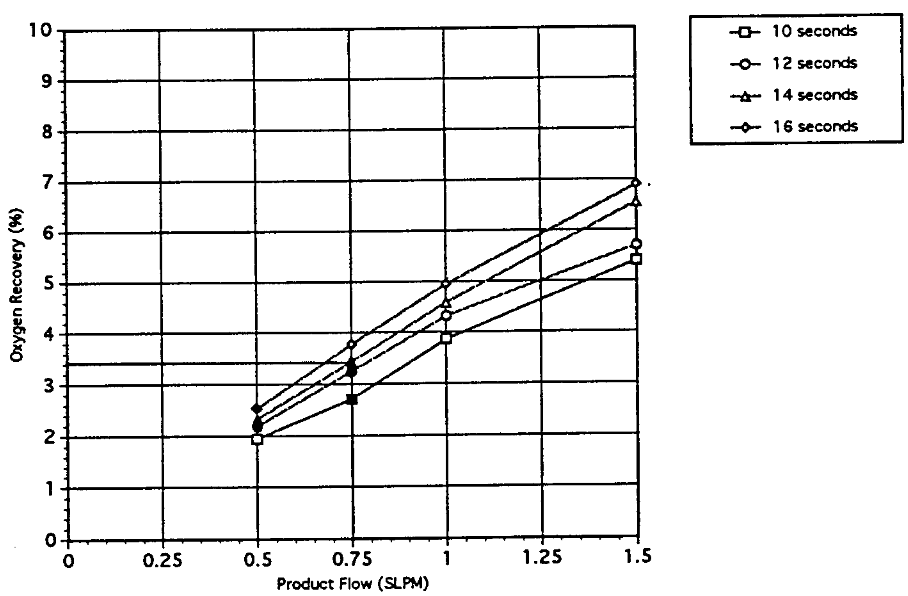

Figure 4. Oxygen Recoveries of a MSOC with a purge orifice of 0.028 inches I.D. at 45 psia (Shaded symbols are those that had over 99% pure oxygen)

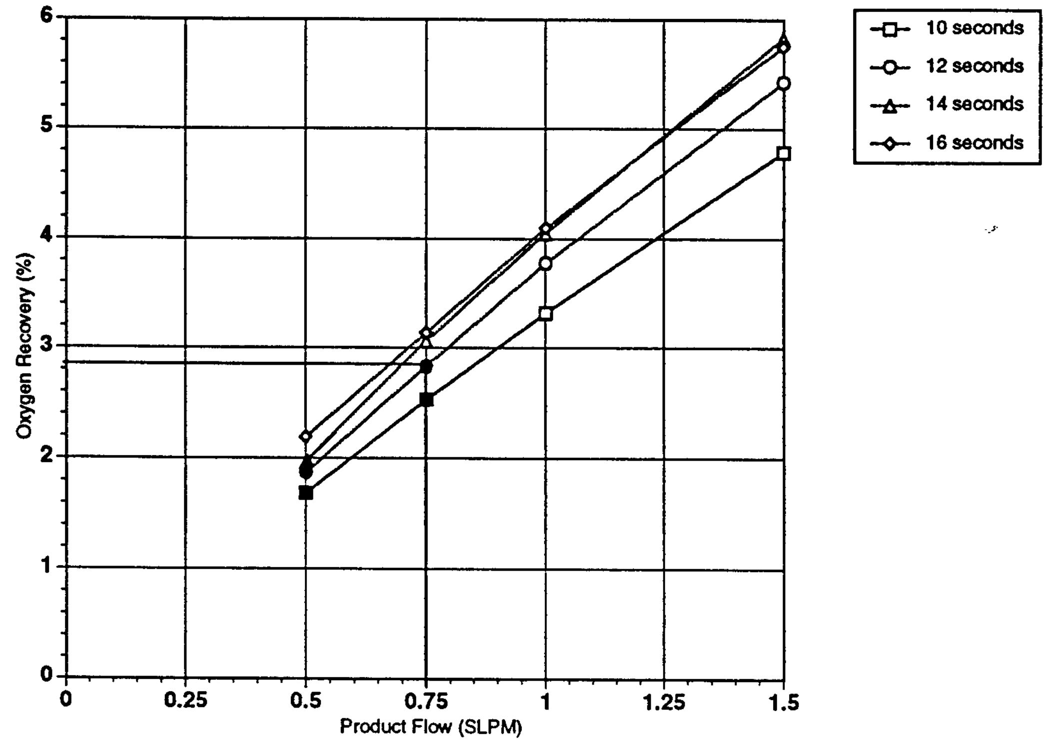

Figure 5. Oxygen Recoveries for a MSOC with a purge orifice of 0.028 inches I.D. at 55 psia. (Shaded symbols are those that had over 99% pure oxygen)

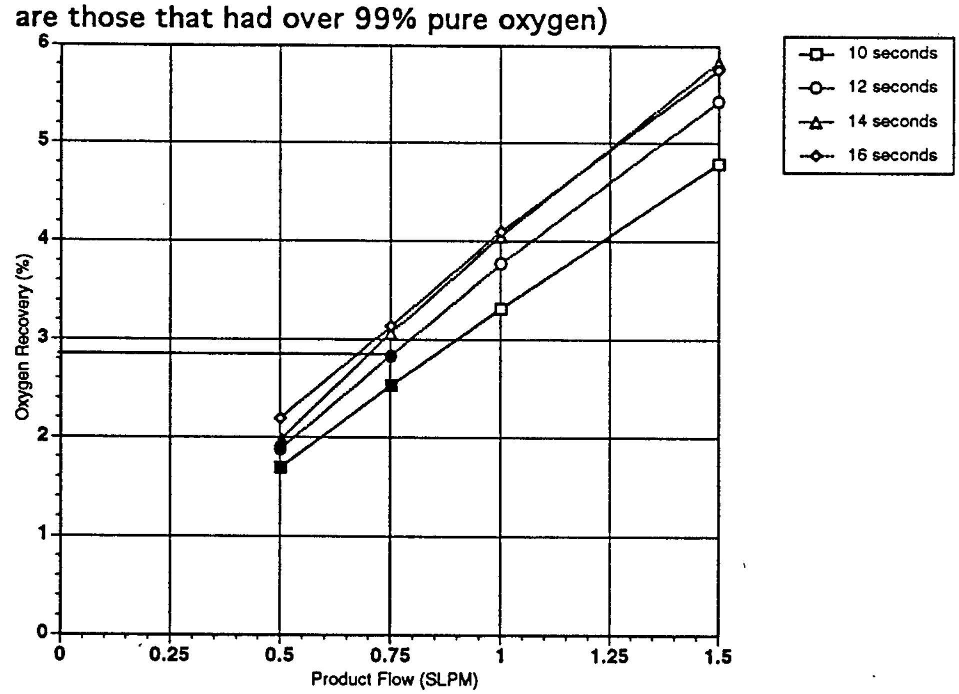

Figure 6. Oxygen Recoveries for a MSOC with a purge orifice of 0.040 inches I.D. at 35 psia. (Shaded symbols are those that had over 99% pure oxygen)

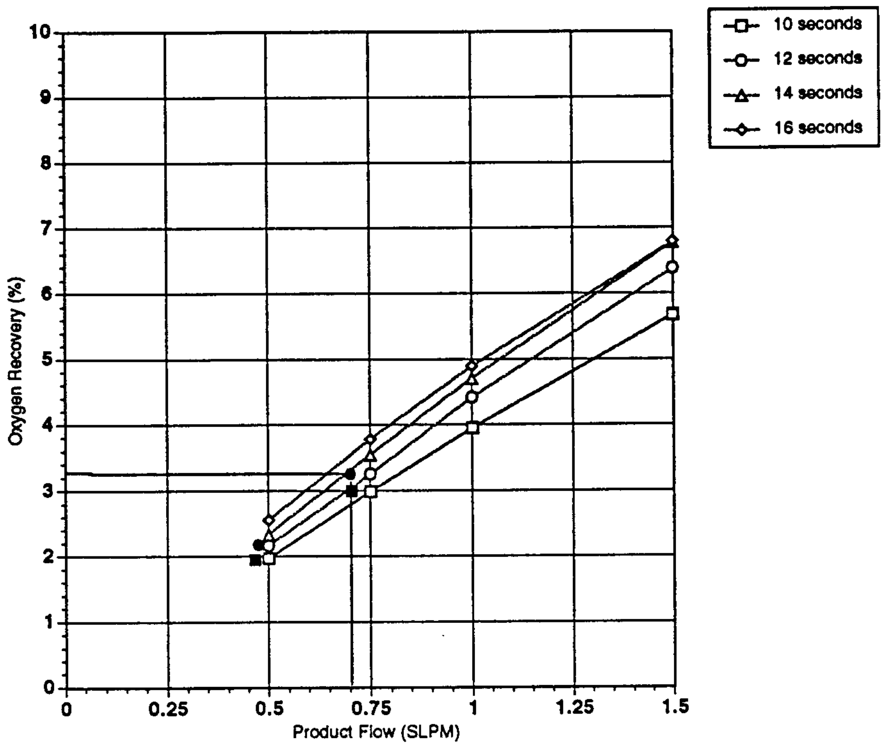

Figure 7. Oxygen Recoveries for a MSOC with purge orifice of 0.040 inches I.D. at 45 psia. (Shaded symbols are over 99% pure oxygen.)

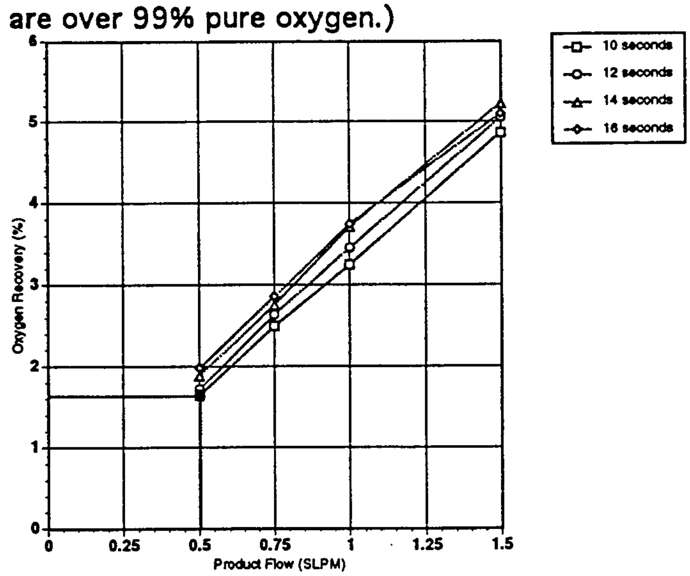

Figure 8. Oxygen Recoveries for a MSOC with purge] orifice of 0.040 inches I.D. at 55 psia (Shaded symbols are over 99% pure oxygen.)

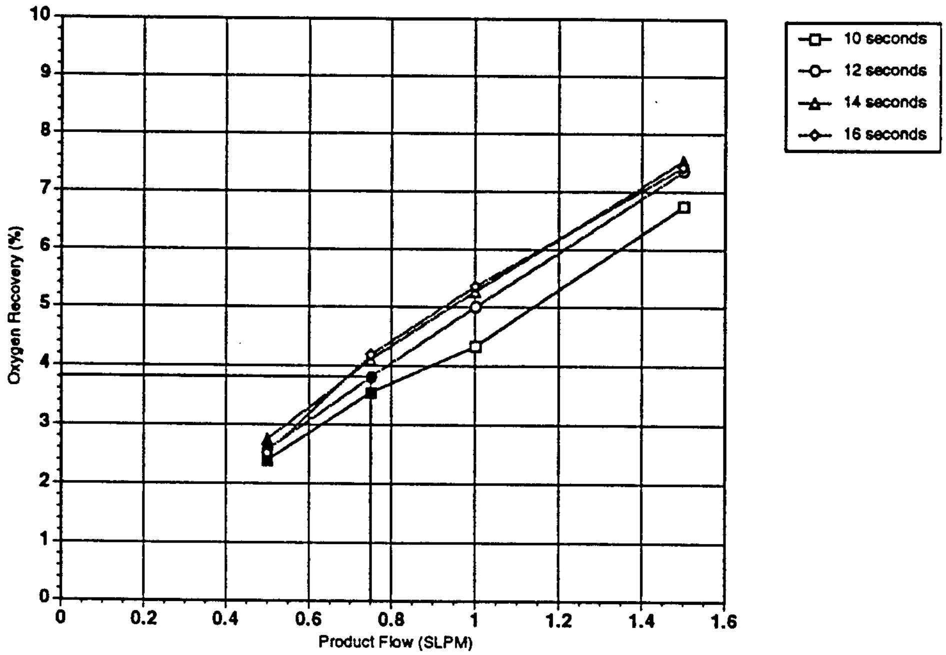

Figure 9. Oxygen Recoveries for a MSOC with a purge orifice of 0.055 inches I.D. at 35 psia (Shaded symbols are those that had over 99% pure oxygen)

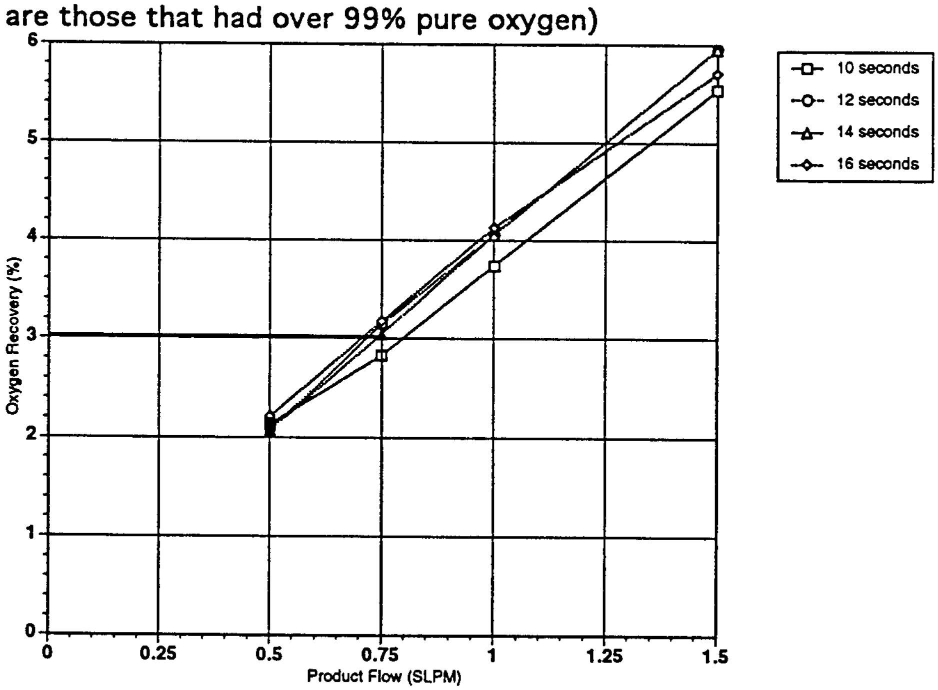

Figure 10. Oxygen Recoveries for a MSOC with a purge orifice of 0.055 inches I.D. at 45 psia (Shaded symbols are those that had over 99% pure oxygen)

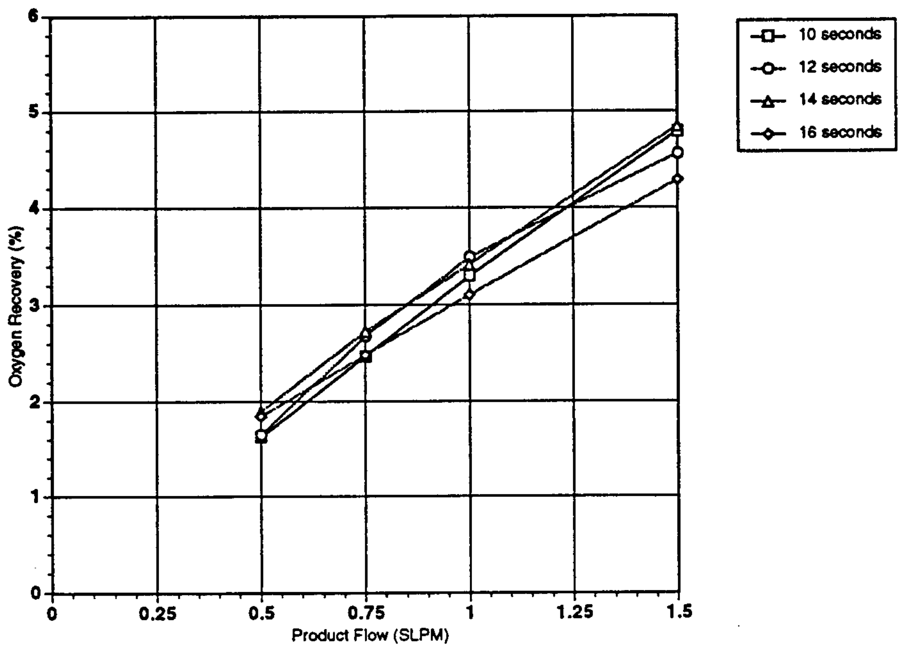

Figure 11. Oxygen Recoveries for a MSOC with a purge orifice of 0.055 inches I.D. at 55 psia (Shaded symbols are those that had over 99% pure oxygen)

Conclusions

The diameter of the purge orifice had a significant effect on the production of 99% pure oxygen. An I.D. of 0.040 inches optimized the oxygen recovery when the MSOC system was operated at 35 psia, a cycle time of 14 seconds, and a product flow of 0.75 SLPM.

Nomenclature

O.D. = outer diameter

I.D. = inside diameter

SLPM = standard liters per minute

psia = pounds per square inch absolute

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Physical and Chemical Characterization of Columbus Air Force Base Aquifer

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High School Apprenticeship Program
Culver City, CA

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Tyndall Air Force Base, FL

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Physical and Chemical Characterization
of Columbus Air Force Base Aquifer

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Abstract

The field experiment, called the Natural Attenuation Study (NATS), will be conducted on an aquifer at Columbus Air Force Base, Mississippi. A large hydrocarbon NAPL (Non Aqueous Phase Liquid) will be emplaced in the aquifer, and soil characterization before and after the emplacement of the NAPL will be measured. One of these measurements will be the determination of iron levels. This study will concentrate on the iron analysis performed on several soil samples from the Columbus aquifer prior to the emplacement of the NAPL. The iron content will be determined using colorimetric determination. The Natural Attenuation Study will be used to test the hypothesis that ferric iron oxide minerals commonly occurring in oxygenated aquifers degrade hydrocarbon contaminants after oxygen has been locally depleted by aerobic degradation. This information is needed to determine whether the aquifer has an oxidizing capacity considerably in excess of that provided by the dissolved oxygen in ground water. The data obtained during this study will be used to test predictive models during the course of natural attenuation. These models will help determine the fate of groundwater contaminants, make contaminant cleanups more efficient, and help in developing methods for slowing down the spread of these contaminants.

Physical and Chemical Characterization of Columbus Air Force Base Aquifer

Angela Foth

Introduction

Natural attenuation is a term used to describe the physical and chemical changes occurring in aquifers that diminish contaminant concentrations over time without human intervention. A field experiment called the Natural Attenuation Study (NATS) will be conducted by the United States Air Force, Armstrong Labs/Environmental Quality AL/EQC) in an unconfined aquifer at Columbus Air Force Base, Mississippi (Figures 1&2). In NATS, a large hydrocarbon NAPL will be emplaced in the aquifer. The leaching, transport and geochemical fate of the NAPL components will then be observed over space and time to measure their natural attenuation by processes including microbial degradation, dilution and evaporation.

The NATS experiment has several research objectives that will provide information to support the process of natural attenuation as a remediation against contaminated groundwater sites. One of these objectives is to gain a better understanding of natural attenuation processes in aquifers so that natural attenuation can be developed as a remediation action. The NATS field experiment is being conducted to provide quantitative information that will demonstrate the practicality of natural attenuation as an alternative remediation action.

The tasks that must be performed in a natural attenuation action include characterization, monitoring, and predictive modeling. If natural attenuation is realized within the site land parcel and no groundwater is being used from aquifer regions with contaminant concentrations exceeding water quality standards, then natural attenuation is considered a successful remediation action.

This study will concentrate on the characterization step of the Columbus AFB Aquifer, specifically on the colorimetric determination of iron at the site. The absorbance will be measured using the BECKMAN UV\VIS Spectrophotometer.

THE PROCEDURE

Preparation of Reagents

Reagents were made before beginning any part of the procedure. They were made as follows.

Step 1: 5N Ammonium acetate- 100 milliliters of Milli-Q water was added to 38.54 grams of Ammonium acetate.

Step 2: 10% Hydroxylamine hydrochloride- 90 milliliters of Milli-Q water to 10 grams of Hydroxylamine hydrochloride.

Step 3: o-Phenanthroline- .30 grams of o-Phenanthroline monohydrate was dissolved in Milli-Q water by heating the mixture to 80 C. The solution was then cooled and Milli-Q water was added to make a final volume of 100 milliliters.

Step 4: 6N Hydrochloric- 100 milliliters of 12 N Hydrochloric acid was added to 200 milliliters of Milli-Q water.

Step 5: 100 ppm Fe solution- .7022 grams of fresh ferrous ammonium sulfate hexahydrate was dissolved in 3.6N Sulfuric acid and the mixture was warmed if necessary. The solution was then diluted to 1 liter.

Step 6: 1N Sodium Acetate- 13.608 grams of Sodium Acetate was added to 100 milliliters of Milli-Q water.

Step 7: 3.6 Sulfuric Acid- 50 milliliters of sulfuric acid was added to 500 milliliters of Milli-Q water.

Step 8: 1N Hydrochloric acid- 100 milliliters of 12 N Hydrochloric acid was added to 1000 milliliters of Milli-Q water.

METHODOLOGY

Soil Preparation

The twenty one core samples collected from Columbus Air Force Base, Mississippi were dried over night in an oven at 30 C, then sifted through a 2 mm sieve. The greater than 2 millimeters samples were put into storage and the less than 2 millimeters samples were tested using the reagents that were prepared in advance.

Sample Preparation

To prepare the samples 3 grams of the soil was weighed out, recording the exact weight in a laboratory notebook. Triplicates of each sample was run. 3 grams of Ottawa sand was weighed out to be used as a blank. Each soil sample was placed into separate 250 milliliter Erlenmeyer flasks. 50 milliliters of 1N Hydrochloric Acid was added to each of flask. The flasks were then covered and placed on a stirrer and the samples were stirred for 2 hours (During the stirring process, standards for the calibration curve were prepared). After the samples had stirred for 2 hours, the flasks were removed from the stirrer. After the 2 hours of stirring, the iron was extracted from the soil. Each of the samples were then poured into centrifuge tubes and centrifuged for 10 minutes at 2000 RPM. The centrifuged samples were then filtered into 100 milliliter volumetric flask, using #40 sized filter paper. The centrifuge tubes were rinsed with a minimal amount of 1N Hydrochloric acid to ensure total sample recovery. 8 milliliters of 6N Hydrochloric acid was added to each volumetric flask and Milli-Q water was added to bring the solution to volume. 1 ml of the 50 milliliters sample was then extracted and put into a clean 50 milliliter volumetric flask and 5 milliliters of 5N Ammonium acetate, 2.5 milliliters of 10% Hydroxylamine hydrochloride, and 2.5 milliliters of o-Phenanthroline was added to each of the flask with the 1 milliliter of sample. The solutions were then brought up to volume with

Milli-Q water and the pH was checked. The pH had to be between 3 and 5.

Reading the Results

Next the absorbance was measured on the UV/VIS spectrophotometer set at 510 nanometers. The absorbance was recorded, and concentration in parts per million (ppm) was calculated against the daily calibration curve. The percent iron was determined by the following equations:

sample ppm - blank ppm = x ppm (mg) (1)

x mg * (1g/1000mg) = y grams (2)

(y/weight of soil)*100% = concentration of iron % (3)

If the result wasn't between 1 and 5 percent iron, adjustments were made to the amount of soil or final volume.

Quality Control

A daily calibration curve was run using the following procedure. An aliquot (0, 5, 15, 25, 35, and 45 ml) of a 5-ppm solution of ferrous iron (Fe) was placed in a series of 100 milliliter volumetric flasks. 2 milliliters of 10% Hydroxylamine hydrochloride was added and the flask was shaken. 2 milliliters of o-Phenanthroline reagent was then added and 1N NaOAc solution was added dropwise until a bright orange or red color appeared. The solution was then diluted to volume with distilled water. The colored solutions contained, respectively, 0.00, 0.25, 0.75, 1.25, 1.75, 2.25 pm of Fe. The solutions were then transferred to 1 centimeter cuvettes and placed in the spectrometer using a wavelength setting of 510 nanometers. The galvanometer was set to 100% light transmission with a tube of distilled water. The percent transmission for each standard was determined and a calibration curve was constructed for the unknown samples concentrations were then determined from the calibration curve.

Results

The iron analysis study which was run on the soil samples from Columbus Air Force Base aquifer demonstrated expected results that compared with the results from earlier studies (Table 1).

Conclusion

In conclusion it can be determined that there are iron oxides present and if the iron oxides deplete after the NAPL is emplaced in the aquifer then ferric iron oxide minerals commonly occurring in oxygenated aquifers degrade hydrocarbon contaminants after oxygen has been locally depleted by aerobic degradation.

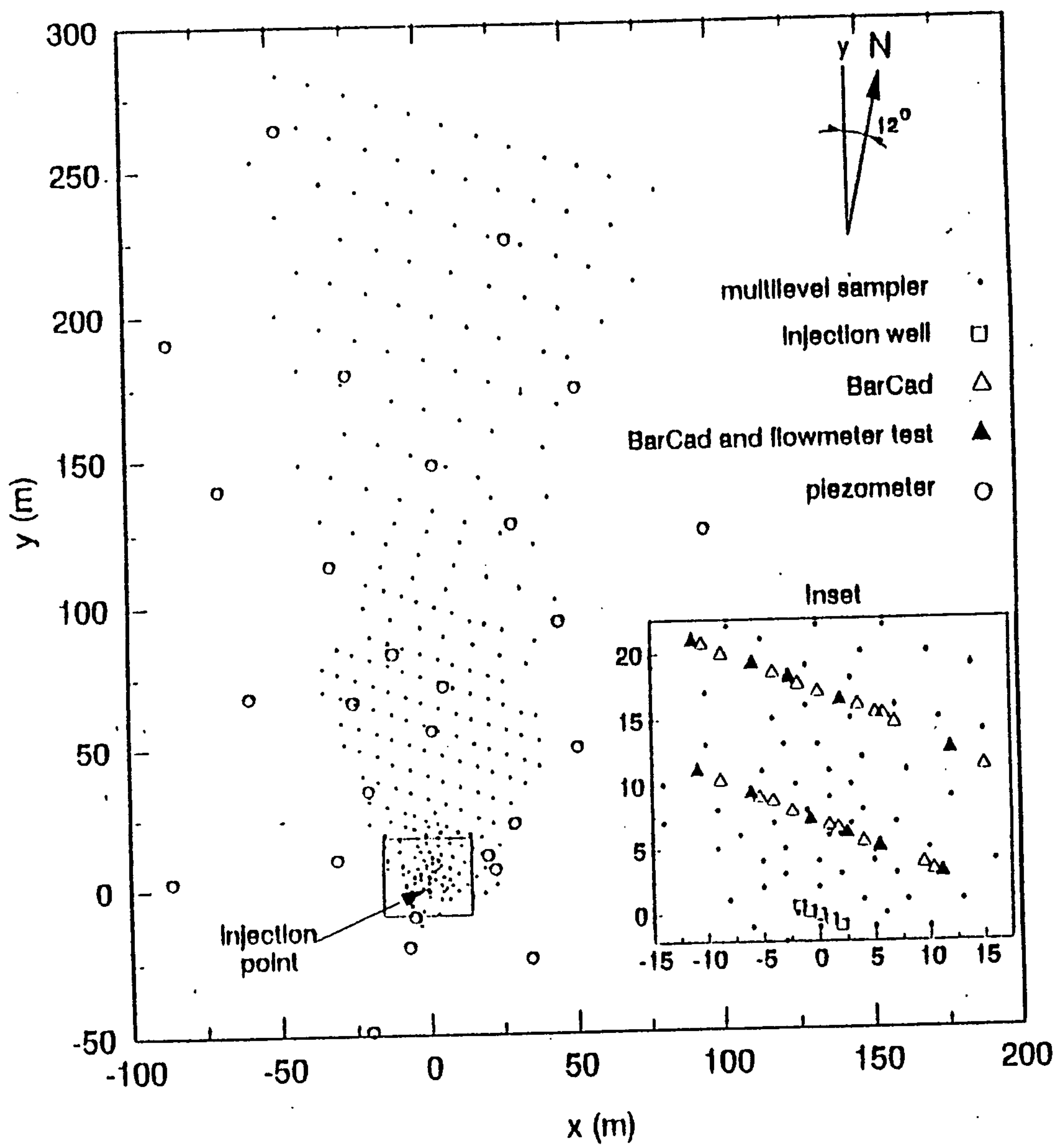
References

W.G. MacIntyre and T.B. Stauffer, C.P. Antworth. Description and Statement of Research Objectives for a New Field Experiment on Natural Attenuation of Organic Contaminants Emplaced as a NAPL in an Aquifer at Columbus AFB, Mississippi.

W.G. MacIntyre, School of Marine Science, College of William and Mary, Gloucester Pt., Virginia 23062

C.P. Antworth, AL/EQC, Tyndall AFB, Florida 32403-6001.

Figure 1



y
N
12°
multilevel sampler
injection well
BarCad
BarCad and flowmeter test
piezometer
Inset
injection point
y (m)
x (m)
300
250
200
150
100
50
0
-50
-100
-50
0
50
100
150
200
20
15
10
5
0
-15
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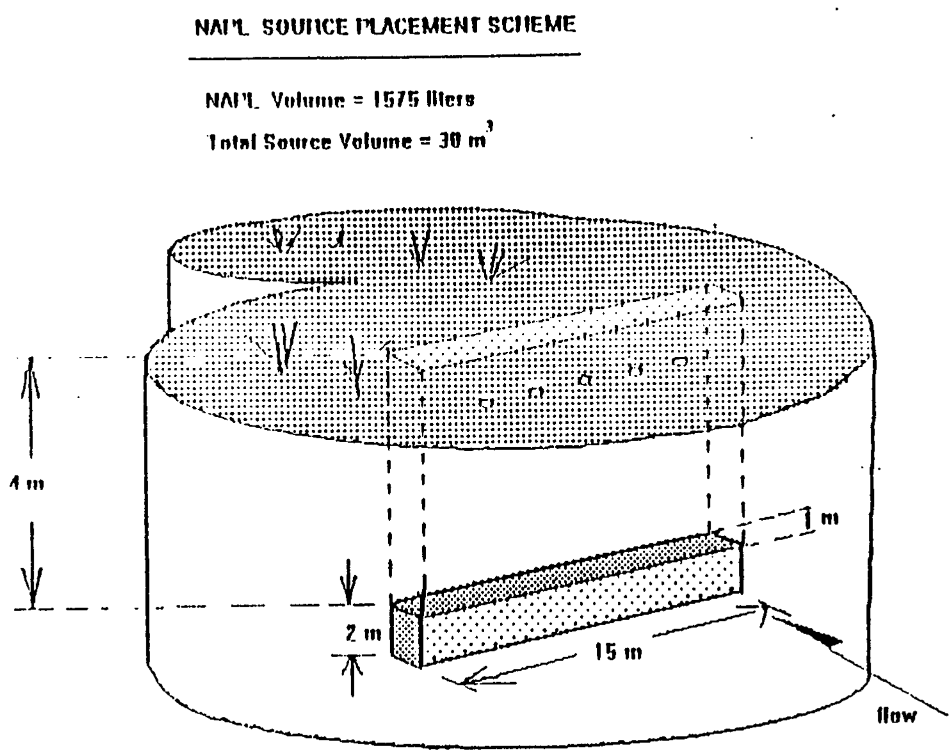
-5
0
5
10
15

Figure 2


NAPL SOURCE PLACEMENT SCHEME
NAPL Volume = 1575 liters
Total Source Volume = 30 m³
4 m
1 m
2 m
15 m
flow

Iron Analysis Results	Core	%
	CM3 D1	0.004857
	CM3 D2	0.005501
	CM3 D3	0.005384
	CM3 D4	0.000805
	CM3 D5	0.002017
	CM3 D6	0.001961
	CM3 D7	0.007821
	CM6 D1	0.016721
	CM6 D2	0.003723
	CM6 D3	0.011223
	CM6 D4	0.009465
	CM6 D5	0.000325
	CM6 D6	0.002182
	CM6 D7	0.00206
	CM9 D1	0.003209
	CM9 D2	0.00392
	CM9 D3	0.023693
	CM9 D4	0.003733
	CM9 D5	0.010756
	CM9 D6	0.00413
	CM9 D7	0.000347
Ranged comared to:	0.0014	0.0393

Table 1

A STUDY OF THE MORTALITY RATE OF THE TEST ORGANISM DAPHNIA PULEX WHEN EXPOSED TO A BROOKS AIR FORCE BASE WATER SAMPLE USING THE REFERENCE TOXICANT SODIUM CHLORIDE

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Final Report For:
High School Apprentice Program
Armstrong Laboratory

Sponsored By:
Air Force Office of Scientific Research
Bolling Air Force Base, DC
and
Armstrong Laboratory

July, 1994

A STUDY OF THE MORTALITY RATE OF THE TEST ORGANISM DAPHNIA PULEX WHEN EXPOSED TO A BROOKS AIR FORCE BASE WATER SAMPLE USING THE REFERENCE TOXICANT SODIUM CHLORIDE

Andrea L. Freeman
Judson High School

Abstract

A forty-eight hour study of the acute toxicity of a water sample generated on Brooks Air Force Base was conducted. Laboratory-bred Ceriodaphnia pulex were placed into the test water, and the survival of the test species was monitored in order to determine both the possible toxicity of the dilution water and also to determine any possible inherent defects within the test organisms which are bred and contained within the laboratory. The reference toxicant sodium chloride was utilized. The EC_{50} (concentration in which 50% of the organisms died) was mathematically determined and compared to the given range specified by the Environmental Protection Agency. Reference toxicity tests are used to determine the soundness of the effluent toxicity data generated by the toxicity tests routinely performed here at Brooks Air Force Base[1].

A STUDY OF THE MORTALITY RATE OF THE TEST ORGANISM DAPHNIA PULEX WHEN EXPOSED TO A BROOKS AIR FORCE BASE WATER SAMPLE USING THE REFERENCE TOXICANT SODIUM CHLORIDE

Andrea L. Freeman

Introduction

The Bioassay and Ecology Function exist mainly to provide both aquatic and terrestrial bioassay testing for all Air Force bases throughout the world. Each ecological test customarily serves to compare the mortality of a water or soil dwelling organism when placed in a potential contaminant to the response of an organism identical in age and species, when subjected to an uncontaminated control. Although chemical analysis is primarily utilized to provide effective information regarding the makeup of contaminated water, products, or soil, only a bioassay, or, "aquatic toxicity test[3]," may be used to evaluate the actual danger such a contaminant may present to the organisms in a particular environment.

An aquatic bioassay employs the use of aquatic organisms so as to successfully assess the toxicity of a particular water sample. The Bioassay function maintains laboratory cultures of four different organisms which are to be used as test subjects. These organisms include: Ceriodaphnia dubia and Daphnia pulex (water fleas); Selenastrum capricorntum (algae), and Pimephales promelas (fathead minnows). Both the Ceriodaphnia and the Daphnia pulex species feed upon algae and numerous other microorganisms, breathe dissolved oxygen, reproduce quite rapidly, and are extremely sensitive to a myriad of contaminants.

Through the successful utilization of bioassay test capabilities, many Air Force bases are able to apply the procedures necessary to lessen, and ultimately eliminate the environmental impact of such contaminants.

Discussion of Problem

The test organisms and dilution water formulated and retained within the laboratory must be tested regularly for any abnormalities within their physiological state. Because the test organisms and testing waters generated within the laboratory are used regularly in the chronic toxicity tests performed within the laboratory, it is imperative that the testing organisms, in this case, Daphnia pulex, and the dilution water remain in peak testing conditions at all times in order to ensure the validity of the toxicity tests.

Methodology

Primarily, the test water must be tested for pH, dissolved oxygen content, temperature, alkalinity, conductivity, and hardness. Each of these measurements must be recorded on the data collection sheet for possible future reference. The toxicity test is begun by setting up the control. The control consists of an uncontaminated, moderately hard dilution water which is mixed daily in the laboratory. The control water must be poured evenly into four separate 50mL non-toxic disposable plastic beakers, each labeled with a C, to indicate that the beakers are housing the control water. The concentrations containing the reference toxicant sodium chloride are made by using an identical moderately hard dilution water. Sodium chloride is added to the water at a rate of 0.25 milligrams per liter of dilution water. In order to make each concentration, a 1000mL flask is filled with the moderately hard dilution water, and 0.25 milligrams of sodium chloride are added to the water, at which point the flask must be shaken vigorously. (This initial concentration is called the 100% concentration, as the solution has been in no way diluted.) Then, 500 mL of the solution are poured evenly into four separate disposable plastic beakers labeled 100a, 100b, 100c, and 100d. These beakers act as the testing chambers for the organisms. The water which remains after each chamber has been filled is then tested for the dissolved oxygen content, pH, and temperature. Next, 500mg of water are added to the flask; the flask is shaken, and again the water is poured into each of four separate testing chambers; this time labeled 50a, 50b, 50c, and 50d, as the solution is now fifty percent less concentrated than the original. This process is repeated for the 12.5%, 25%, and 75% concentrations. Five Ceriodaphnia neonates (babies) must then be carefully pipetted from their breed containers into each of the twenty-four containers housing the test waters.

In order to ensure the success of the Ceriodaphnia Acute Toxicity Test, each organism must be less than twenty-four hours old, and each within eight hours of the same age. The organisms are procured from individual cultures through the utilization of "brood boards;" the organisms are only taken from adults which have produced eight or more offspring within their third broods. The adults may be used as "brood stock" only until they are fourteen days old[1].

To avoid contamination, all beakers are stored in an environmental chamber where they are covered with clear plastic so as to prevent any debris which may happen into the chamber from coming into contact with the test waters. These plastic sheaths simultaneously prevent an excess of evaporation from occurring. Upon the passing of each twenty -four hour period, the dissolved oxygen content, temperature, pH, and number of surviving organisms within each chamber must be examined, and the information is recorded on the data worksheet. The EC_{50}, or, the concentration at which 50% of the organisms died, must ultimately be determined[1]. The actual EC_{50} dilution (x) which would have to be manufactured in order to produce the EC_{50} concentration is calculated using a simple algebraic equation.

$$\frac{100L}{25mg} = \frac{18.4810}{x}$$

The Environmental Protection Agency utilizes this final calculation as the basis for determining the acute toxicity of the water fabricated in the laboratory, and simultaneously, the reliability of the test subjects generated here in the laboratory[2].

Results

Mortality of the 20 exposed neonates at each concentration was 5, 14, and 19 at 12.5, 25, and 50% concentrations, respectively. All exposed neonates exposed to the 75 and 100% concentrations died (Table 1).

Table 2 exhibits the confidence limits and the estimated EC values derived from the test from 1% to 99%.The concentration in which 50% of the organisms would have theoretically died, based on the data derived from this toxicity test, or the EC_{50}, was figured to be an 18.4810% concentration of the reference toxicant sodium chloride.

TABLE 1

Toxicity Test Daphnia Pulex Survival July 94

Conc.	Number Exposed	Number Resp.	Observed Proportion Responding	Adjusted Proportion Responding	Predicted Proportion Responding
12.5000	20	5	0.2500	0.2500	0.2434
25.0000	20	14	0.7000	0.7000	0.7045
50.0000	20	19	0.9500	0.9500	0.9616
75.0000	20	20	1.0000	1.0000	0.9936
100.0000	20	20	1.0000	1.0000	0.9987

Chi - Square Heterogeneity = 0.235

Mu = 1.266726
Sigma = 0.244228

Parameter	Estimate	Std. Err.	95% Confidence Limits	
Intercept	-0.186655	1.091390	(-2.325779,	1.952470)
Slope	4.094535	0.798329	(2.529811,	5.659259)

Theoretical Spontaneous Response Rate = 0.0000

TABLE 2

Toxicity Test Daphnia Pulex Survival July 94

Estimated EC Values and Confidence Limits

Point	Conc.	Lower 95% Confidence Limits	Upper 95% Confidence Limits
EC 1.00	4.9955	1.9129	7.8361
EC 5.00	7.3282	3.5137	10.4657
EC10.00	8.9893	4.8421	12.2549
EC15.00	10.3183	5.9977	13.6649
EC50.00	18.4810	14.0517	22.8388
EC85.00	33.1012	26.5072	47.4074
EC90.00	37.9952	29.8819	58.0836
EC95.00	46.6076	35.3481	79.2316
EC99.00	68.3712	47.6602	144.1653

Conclusions

In order for the reference toxicity test to be considered "passable" based upon the standards set by the Environmental Protection Agency, the mathematically computed EC_{50} dilution must fall within the following range: 2.86 mg/L - 17.5 mg/L[2]. As the theoretical EC_{50} of this test was found to be 4.62 mg/L, the test was successful. The dilution water which is fabricated within this laboratory to be used as the control water in the chronic toxicity tests conducted here regularly is not in any way toxic, and the water dwelling organisms bred within the lab exhibit no inherent defects, however, because the EC_{50} was found to be somewhat low within the given range, it may be concluded that the test organisms were quite sensitive to their environmental conditions, and therefore slightly more fragile than most test subjects, especially considering the high quality of the test water.

References

1. Operating Instructions For AL/OEMB, Ecology and Bioassay Function, Roderick Harris, Capt, USAF, BSC Chief, Ecology and Bioassay Function, 1993.

2. Methods for Measuring the Acute Toxicity of Effluents to Freshwater Water and Marine Organisms, EPA/600/4 - 90/027.

3. Standard Methods for the Examination of Water and Wastewater, (16th Edition) (Standard Methods).

A STUDY ON THE EFFECTS OF CHRONIC INTERMITTENT EXPOSURES TO MEDIUM +GZ

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Final Report for:
High School Apprentice Program
Armstrong Laboratory

Sponsored by:
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Bolling Air Force Base, DC
and
Armstrong Laboratory

September 1994

Abstract

With the wide spread use of high performance aircraft capable of sustained high +Gz the USAF has interest in the effects of acceleration and +Gz on the human body and mind. As a continuation of a previous study on chronic multiple high +Gz, male Sprague-Dawley rats were exposed to +15 Gz on a chronic intermittent schedule using a small animal centrifuge. Instrumented control groups were exposed to +.5Gz (base) and a non-instrumented positive control group was kept in the vivarium. Histological data is still being processed, but initial anaylsis points to a relatively small amount of stress being placed on the subjects due to acceleration and little neurological damage is expected to be found.

Introduction

The Air Force, through research and development, has created a new generation of fighters which have the ability to fly at high sustained +Gz. This maneuvering abilities are absolutely necessary in many circumstances in order to maintain air superiority. New materials and construction techniques have made the physical hardware of the planes able to withstand these harsh conditions and so the "weak link" in the system is the human body, or the human factor.

A pilot who can not maintain consciousness is a liability to the overall performance of the airplane, and so Armstrong Laboratories is conducting experiments to both understand the effects of +Gz on the human body and to protect the body from any adverse results. A previous study determined the effects of centrifugation to the point of G-LOC (Gravitationally Induced Loss Of Consciousness) but did not give decisive data on the effects of slightly lesser +Gz exposures which may simulate those which pilots are exposed to on a regular basis.

Methods and Materials

Twenty eight male Sprague-Dawley rats were surgically instrumented with EEG (electroencephalograph) prior to the beginning of experimentation and allowed to recover at least two days. At this point the instrumented rats were divided by weight into four groups of seven such that the groups total weights were approximately equal. Groups were designated as Monday-Wednesday-Friday (MWF) or Tuesday-Thursday (TTh). Each group was then sub-divided into experimental and control. Seven remaining rats were designated as positive control and were never subjected to either centrifugation or surgery. The two experimental groups were exposed on their assigned days to (MWF) four and (TTh) six peaks at 15 +Gz. The control groups were likewise exposed to respective number of peaks of .5 +Gz. This pattern was followed for five weeks.

The animals were restrained in plexiglass containers with bite bars to secure the head in place with plates at the posterior to prevent backwards movement out of the restraint. A standard amount of padding was placed between the rat and the butt plate. The containers (seven at a time) were then placed in a small animal centrifuge with a diameter of five feet.

Centrifuge control was done by computer and a Macintosh IIFX was used to collect data from the EEG implants and store it for later analysis.

Weights of the individual rats were recorded prior to centrifugation on each day, with the positive control weight being collected on MWF.

When required, after centrifugation the wounds from surgery were cleaned with hydrogen peroxide, restitched, and treated with Neosporin ointment. Any additional care was given as needed.

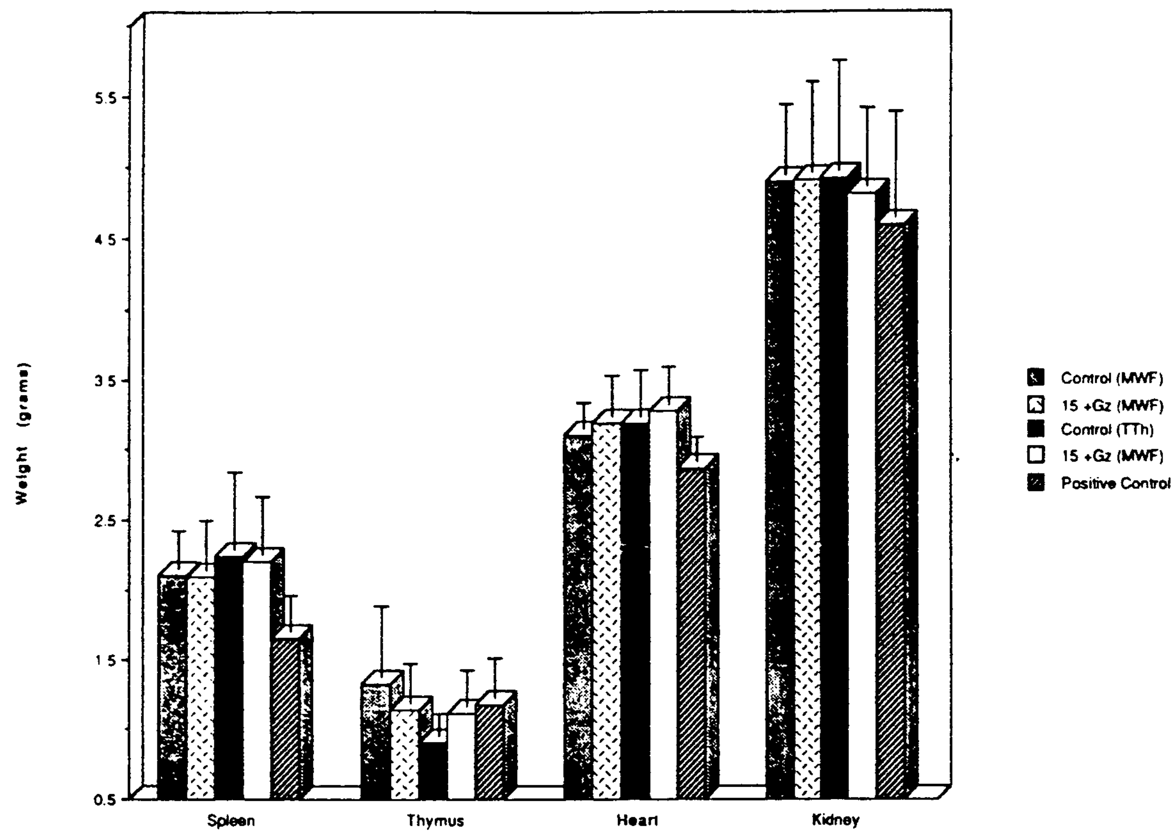
At the completion of the protocol the animals were weighed and then sacrificed and perfused with paraformaldahyde. A blood sample was removed for a hematocrit. The brain, kidney, and stomach were removed and preserved for histological study and the adrenals, spleen, thymus, and lungs were removed and weighed. A blood sample was also analyzed for percentage of white blood cells.

Results

At this point all results are preliminary and have not been statistically analyzed so they are not definite, but there are still trends which give strong indications. First there is organ weight.

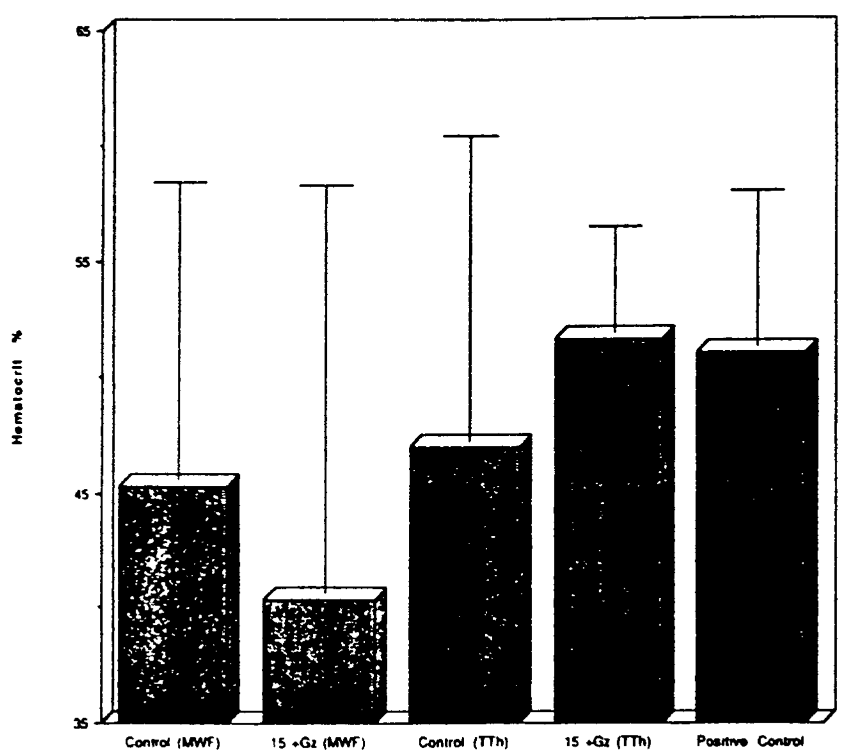
All of the individual organ weights, with the exception of the thymus, show the same basic distribution of approximately the same average weight in all centrifuged animals and a lesser weight for the positive control. The various organ weights are shown as the average for the particular group with standard deviation error bars.

Normalized Organ Weights



The hematocrit does not show this same pattern, as seen below.

Hematocrit



Conclusions

The data for the most part shows what is expected. The pattern seen in the organ weights is most likely due to the increased stress the animals went through during the process of being prepared for centrifugation rather than due to the +Gz they were exposed to. This is clear since there is no apparent difference in weights between the experimental animals and the active controls. The stress of medium +Gz is not significant to the health of an organism even when subjected chronically. This is good news for pilots since they are exposed to similar conditions daily.

This same conclusion is backed up by the hematocrit. Since stress causes an organism to decrease its blood cell production, one would see a much higher percent of red blood cells in positive control animals then in experimental if there was significant stress put on the experimentals. The lack of a real difference in percents leads one to conclude that there is no significant additional stress caused by medium +Gz exposures.

It should also be noted that there were no G-LOCs observed (except when a exposure run was accidentally left on too long). This means that the steady exposures to medium +Gz did not weaken the rats G-tolerance over time which is also a positive finding for the Air Force.

At this time it appears that there is no adverse affect to living organisms caused by low to medium exposures to +Gz.

ENVIRONMENTAL RESTORATION TECHNOLOGIES RESEARCH AND DEVELOPMENT

Mark W. Giles

High School Apprenticeship Program

Final Report for:

Summer Research Extension Program

Armstrong Laboratory

Sponsored by:

Air Force Office of Scientific Research

Tyndall Air Force Base, Florida

August 1994

ENVIRONMENTAL RESTORATION TECHNOLOGIES RESEARCH AND DEVELOPMENT

Mark W. Giles

ABSTRACT

This work was sponsored by the Armstrong Laboratory Environics Directorate at Tyndall Air Force Base, Florida. Program management and environmental cleanup technologies for removing fuels and solvents from soils and groundwater at contaminated Air Force Bases are the focus of this agency's research and development activities. The program documentation essential for the initiation and direction of the development efforts are explained, such as the program planning preparation from contractor proposals. The main environmental technology observed during the period of June to August 1994, was the Radio Frequency/Vapor Extraction technology.

ENVIRONMENTAL RESTORATION TECHNOLOGIES RESEARCH AND DEVELOPMENT

Mark W. Giles

INTRODUCTION

This report is an overview of the organization, management and operational functions of the Armstrong Laboratory Environics Directorate involvement in Environmental Research and Development activities observed during on eight week period from June to August 1994.

Observations were made at the Laboratory Program Management Level where every activity from the initiation to termination of an Environmental Remediation R&D effort could occur. The overall result was a unique and rare view of the combined effort of scientific and engineering professionals interacting at all levels of R&D ranging from pure research, bench and pilot scale demonstrations, to final fielding of the total treatment system design accompanied with related technical information exchange and reporting activities.

Although these observations were made at an Air Force Program Management Office, cooperation and formal coordination occurred on a daily basis with virtually every environmental interest group across other government agencies such as the Environmental Protection Agency, the Department of Energy, the Department of Defense, and specialized R&D groups in industry and academia.

ORGANIZATION AND OBJECTIVES

The Environics Directorate

A subset of the Armstrong Laboratory with headquarters at Brooks Air Force Base, Texas, the Environics Directorate (AL/EQ) at Tyndall Air Force Base, Florida is the Air Force's lead agency for Environmental research and Development (R&D) to reduce the threat of hazardous materials released in past operations, and to upgrade system designs and maintenance methods which will reduce or totally eliminate toxic effluents to the environment.

The primary objective of the Environics Directorate is the development of environmental technologies that may provide and assortment of valuable tools to be applied in pure research, environmental compliance with existing laws and regulations, and new and innovative treatment methods to remove hazardous materials from air, soil and groundwater.

The Engineering Management and Research Laboratory Staff

Some of the methodologies and techniques that are used in the characterization and treatment of different kinds of pollutants fall mainly into five R&D thrust areas: Site Characterization and Monitoring Systems; Fate, Transport and Effect Investigations, Bioremediation Studies above (ex-situ) and underground or in-place (in-situ); Physical Treatment Process Development and Upgrades; and Chemical Treatment Studies. These five thrust areas are addressed in a matrix management approach among three divisions in the Environics Directorate: the Environmental Interactions Division (EQS), the Environmental Compliance Division (EQC), and the Site Remediation Division (EQW).

The above described organizational structure permits all of the laboratory's resources to focus on the environmental assessment of different kinds of pollutants and their sources during natural or mechanical transport, interaction with natural elements and other hazardous materials, and their ultimate decomposition into non-toxic states. Technical performance evaluations and cost effectiveness of new and innovative biological and chemical processing systems are of vital interest in scientific laboratory studies and engineering design and field demonstration evaluation exercises. Finally, the ability to control optimized systems and their operating methodologies to solve real hazardous waste contamination problems are transferred to Air Force Environmental Management Offices and facility operators in design handbooks and operating manuals.

Program Planning

The Program Planning Office is responsible for laying out the strategy by which all R&D work is directed toward Air Force Site Restoration Requirements. With the discovery of a problem, a plan and a program are created. The program planning begins when a technical problem is identified with an Air Force requirement or statement of need to solve a site or process specific problem. To be able to actively pursue and find a solution for the problem, there must be enough money available to fund a program aimed at solving the Air Force's need. Following the necessary approvals regarding both the technical approach and the appropriate amount of funding, the start of work begins on a scheduled plan that includes completion of significant milestones. Conceptual design, pilot scale demonstration, full scale demonstration, and final project review of a detailed technical report are such milestones that must be completed.

ENGINEERING AND SCIENTIFIC R&D PROJECTS

Radio Frequency / Vapor Extraction Technology

The Radio Frequency soil decontamination project is designed to identify, develop, and transition a microwave heating technology to remediate sites that have been contaminated by fuels and solvents at Air Force installations. The RF decontamination of contaminated sites by volatilizing most of the hazardous wastes that exists at the contaminated site. The RF project provides both an efficient and cost-effective decontamination method to installations that are required to cleanup and close hazardous waste sites according to the new environmental laws.

Radio Frequency heating is a proven method for the thermal treatment of clay and sand soils containing volatile hazardous substances such as fuels, hydrocarbons, and solvents. The decontamination of soil is accomplished by volatilization and removal of the hazardous materials in a vaporized form. The heating mechanism is similar to that of a microwave oven, except that the frequency is different and the scale of operation is much larger. The gases and water vapor are recovered and collected from the heated zone and vacuum extracted to a cooling and treatment sub-system.

The Radio Frequency heating of large well defined blocks of soil is achieved by applying electromagnetic energy in an optimally selected RF band to an array of electrodes placed in drilled boreholes. The electrode array is enclosed within a vapor barrier which prevents hydrocarbon vapors from escaping to the outside environment and also facilitates the collection of the gases and vapors for subsequent treatment on or off site.

PROGRAMMING FILTERING ROUTINES IN THE C PROGRAMMING LANGUAGE

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Final Report for:
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Wright Laboratory

Sponsored by:
Air Force Office of Scientific Research
Bolling Air Force Base, DC

and

Wright Laboratory

September 1994

PROGRAMMING FILTERING ROUTINES IN THE C PROGRAMMING LANGUAGE

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Abstract

A large part of my experience at WPAFB this summer was learning the C programming language. A few initial basic tasks were assigned to help me become more familiar with the language. After becoming fairly comfortable with C, I wrote a program that took a signal (a sum of sines wave) and "disrupted" that signal with "noise" (a jagged, random wave). I then wrote three separate filtering routines that filtered out the noise in an attempt to convert the disrupted signal back into the original, clean signal.

PROGRAMMING FILTERING ROUTINES IN THE C PROGRAMMING LANGUAGE

Michael L. Gunzburger

INTRODUCTION

Digital filtration is a common process in the engineering and technology world of today. Filters remove outside or unwanted quantities from such things as light waves, sound waves, and electrical current. One of the many tasks I performed this summer was writing a filtering routine. I programmed it using the C programming language.

METHODOLOGY

Though I was somewhat familiar with other computer languages (namely BASIC & Pascal), C was a new language to me, so roughly the first week of the project was spent just trying to learn the syntax and format of the language. A number of small programming tasks were assigned to help acclimate me to C, such as displaying a sine wave and being able to modify its amplitude, frequency, color, and thickness. Later tasks included interacting with files and creating and using arrays. After gaining some proficiency in the language, I began work on the actual filtering program. For the initial "clean" signal, I generated a wave pattern consisting of a sum of sine waves. To do this I created an array consisting of about four or five integers and saved the values in a file called "data.d". For each point on the x-axis (there are 629 points on the x-axis--roughly the number of pixels across the screen), the program calculates the sine of the first integer multiplied by the x value and saves the product. The same calculation is made for the next integer in the array, and this value is added to the previous total. This process is repeated until all the numbers in the array have been added to create a grand total. Next, the total is multiplied and added to two respective numerical constants for screen output purposes and converted into an integer. A pixel is lit on the screen for the particular x and y value, and then the process is iterated again for the next x value. Here's the program code for this entire process:

```
for (x = 0; x < 629; x++)
{
    oldtotal=0;
    for (m = 0; m < 500; m++)
    {
        temptotal = (150.0 * sin ((x * tsin[m]) / divisor ));
        total = temptotal + oldtotal;
        oldtotal = total;
    }
    doubley = (( multiplier * total) + 169);
    y = ((int) doubley);
```

```
        _lineto(x,y);
    }
```

The "divisor" and "multiplier" terms are program generated constants that modify the values so that they can be cleanly centered and displayed on the monitor; their purpose and origin will be further explained later in this paper. "tsin[m]" is simply the array containing the integers. After the sine wave is created, "noise" is introduced to this "signal". The noise is created in a very similar way to the signal; however, instead of a smooth signal of four or five sine waves added together, the noise signal consists of a 500 point array containing 500 randomly chosen numbers (some high and some low). This creates a very rough, jagged signal, with hundreds of little peaks and valleys--in effect, "noise". It's output on the screen is handled in the same fashion as the regular sum of sines signal.

The next step in building the program was taking the noise signal and adding it to the smooth sum of sines wave to create a "corrupted" signal. It was calculated in much the same way that the other two signals were, except that the 629 x values of the signal were saved into a 629 point array called totalsig[x]. The array in this data was then accessed for output to the screen. The reason for doing the combined signal in this manner, rather than calculating and drawing "on the fly" like the other two signals, was that this corrupted signal is later used by the filtering algorithms. Rather then having to recalculate the combined signal every time I passed it through a filtering routine, it was much more efficient to run it once, and then save the values into the array. Here is the code used to create the combined signal:

```
    for (x = 0; x < 629 ; x++)
    {
        tempnum = 0;
        for (m = 0; m < 500; m++)
            tempnum = (150.0 * sin ((x * tsin[m]) / divisor)) + ( sin ((x * noise[m]) / divisor ))
+ tempnum;
        doubley = ((multiplier * tempnum) + 169);
        combined[x] = (int) doubley;
    }
```

One of the initial problems I ran into was in trying to center the output of the wave graphics. With the particular graphical format I was using, there were 340 pixels vertically and 630 horizontally. To plot a singular point of one of the waves, I would have to multiply the calculated value by a certain factor; otherwise the signal would either end up looking like a featureless straight line or the numbers would be so huge that only a very small part of the signal would be contained within the viewable bounds of the monitor. Normally the multiplying factor would be fairly easy to calculate; for example, with a simple sine of x wave, a multiplying factor of around 100 works every time, because the sine of x is always between one and negative one. However, with a sum of sines (sine 2x + sine 7x + sine 4x...), the answer is not limited to being between one and negative one; it can be much higher or lower. This makes finding the right multiplication factor a laborious trial and error job--and if you ever change the sum of sines signal (or even the noise), you have to spend that much more time trying to find the new multiplication factor that will actually show the waves on the monitor. To fix this problem, I created an "auto-centering" routine which is the first time the program is asked to draw a wave. Basically, it attempts to output the combined signal wave with an initial multiplying factor of 1.0. If any point lies outside the bounds of the viewing rectangle (that is, the y value is below 30 or above 340) it divides the multiplier by 1.1 and tries again and again, until it eventually finds a factor small enough to display the entire wave within the set bounds. Here is the "auto-centering" routine:

```
printf("Processing data");
for (x = 0; x < 629 ; x++)
{
    tempnum=0;
    for (m = 0; m < 500; m++)
    tempnum =  (150.0 * sin ((x * tsin[m]) / divisor)) + ( sin ((x * noise[m]) / divisor )) +
tempnum;
    doubley = ((multiplier * tempnum) + 169);
    combined[x]=(int) doubley;
        totalsig[x]=combined[x];
        totalsig2[x]=combined[x];
        totalsig3[x]=combined[x];
if (x % 100==49 || x % 100==99)
    printf(".");
    if (combined[x] < 30 || combined[x] > 330)
    {
        multiplier = (multiplier / 1.1);
        x = x - 1;
        if(x < 0)  x=0;
        continue;
    }
}
```

After corrupting the smooth signal with the noise wave, I began work on the filtering algorithms whose purpose would be to filter out the noise and ideally render the signal back into its original, uncorrupted form. The first filtering routine I began work on was a simple averaging one. It took each y value and recalculated it as the average of the y value one behind and one in front of it. It then moved on to the next y value and repeated the process. It then saved the newly filtered wave into a new array, so that the next filtering pass would alter the already filtered wave, thus allowing an infinite number of filtering passes. (This was done for all the filtering algorithms.) The code is as follows:

```
for(x = 1; x < 628; x++)
{
    totalsig2[x] = (int) ((totalsig2[x+1] + totalsig2[x-1]) / 2.0);
    _lineto(x, totalsig2[x]);
}
```

The next filtering algorithm I programmed was similar to the averaging one, except for one significant variation. If a particular y value was either higher or lower than the y values just before and after it, it was recalculated as the average of the two. However, if it was between the two it was left alone. Here is the code for this particular filter:

```
for( x = 1; x < 628; x++)
{
if ((totalsig[x] >= totalsig[x+1]) && (totalsig[x] >= totalsig[x-1]))
    totalsig[x] = (int)((totalsig[x-1] + totalsig[x+1]) / 2.0);
    if ((totalsig[x] <= totalsig[x+1]) && (totalsig[x] <= totalsig[x-1]))
    totalsig[x] = (int)((totalsig[x-1] + totalsig[x+1]) / 2.0);
_lineto(x, totalsig[x]);
}
```

The final filtering routine I programmed dealt with slopes. It calculated the slope from one point to the next one. If the slope was found to be above some number (after playing around a bit, I chose the number three), it was divided in half, and the consecutive points were adjusted to match that new slope. The slope was also adjusted if it was below a certain number (negative three). The code is as follows:

```
for(x = 0; x < 628; x++)
{
    slope = (totalsig3[x+1] - totalsig3[x]);
    if ((slope > 3) || (slope < -3))
    {
        slope = slope / 2.0;
        totalsig3[x] = (int) (totalsig3[x] + slope);
        continue;
    }
    _lineto(x, totalsig3[x]);
}
```

The program was displayed in a menu format. The main menu had six different options: (1) Entering data (the sum of sine wave); (2) Saving that data; (3) Restoring previously saved data; (4) Importing the noise signal data; (5) going to the "plotting menu"; and finally, (6) Quitting. The plotting menu contained eight different options, displayed at the top sixth of the screen (the rest is reserved for the wave graphics). They are: (1) Plotting the "clean" sum of sine signal; (2) Plotting the noise wave; (3) Plotting the combined, corrupted signal; (4) Plotting the first averaging filter; (5) Plotting the second filter; (6) Plotting the slope filter; (7) Clearing the screen of all previous graphs; and lastly, (8) Returning to the main menu. As mentioned before, the filtering routines can all be run as many times as needed. Each time they're chosen, they erase the previous filtered wave so that a clear progression can be seen. In addition, a counter on the screen keeps track of each separate filter run. Comparisons are easily made to the original clean signal simply by plotting that clean signal, which will stay graphed until the Clear Screen option is chosen. And lastly, each different wave (including the three different types of filters) is easily distinguished from each other by the use of separate colors for each wave.

RESULTS & CONCLUSION

The averaging filter was perhaps the most effective of the three filters. After roughly ten passes, most of the jerky, rough nature of the noise was gone, leaving an overall smooth signal. Also by that time, the filtered signal matched up fairly evenly with the original clear signal, actually overlapping many parts of it. The main fault with the filtered signal, though, was found at the high and low peaks; before it lined up evenly with the original signal, the round tips tended to get squared off. In addition, if it's run enough times (over 200), one's left with not much more than a straight line.

The second filter worked better in keeping the roundness of the peaks. Unfortunately, it also left in more of the jerky characteristic of the noise file. In addition, after about eight passes, the filter no longer changed the wave. When I changed the routine to have it filter out values that were higher, lower, or *equal* to the values immediately around it, then it did continue filtering on. However, in that case the filtering routine basically mirrored the first averaging routine, only varying slightly in the initial first ten or so stages.

The slope filter was the least effective of the three algorithms. Though it was very effective in removing the noise from the corrupted signal, it had an unfortunate side effect in that the filtered signal quickly lost its curving smoothness, becoming jagged and edgy. Instead of calm, gently rolling hills and valleys, we get the harsh, angled peaks of steep mountains.

Of course, there are many, many other far more advanced and effective filtration methods, such as those involving Fourier transform methods. However, those were beyond the scope of my knowledge, at least with the limited time period I had (this was one of the many projects I worked on). Still, this program was a valuable learning experience, not just from the filtering routines, but even more so from the fact that I learned a very important computer language. I feel I've learned just as much C, if not more, by plummeting head first into this project, than the other languages I've learned in regular, structured classes lasting whole semesters. The hands-on experiences afforded to me by this project and others, as well as simply working in a "real" engineering environment, have truly been rewarding and helpful as I look on towards my future career.

ADDENDUM
(the complete program)

```
/*HOMEWRK2.C: (Filtering program)-- Michael L. Gunzburger, WPAFB (RDL), 7/18/94*/

#include <stdio.h>
#include <stdlib.h>
#include <graph.h>
#include <conio.h>
#include <math.h>
#include <ctype.h>

int create ( int j, int sindata);
void save ( FILE *fp, int number );
void plot ( FILE *fp);

main(FILE *fp)
{
    int tempo, z,c;
    int cnt = 1, count=1;
    char e=-107;

    double doubley, total,temptotal,tempnum;
    int totalsig[629], totalsig2[629],totalsig3[629],same[629];
    int x, y, m, axis;
    float divisor = 100.0;
    int tsin[500], noise[500];
    double oldtotal = 0, multiplier=-1.0, temp_old=0;

    int af=1;
    int spnf=1;
    int slpf=1;
    char buffer[90];

    double slope;

    _setvideomode( _ERESCOLOR );
    for (z=0; z<500; z++) {tsin[z]=0;noise[z]=0;}
    while(cnt==1)
    {
        if (e!=-107)
            getch( );
        _clearscreen( _GCLEARSCREEN );                    /*Main Menu*/
        _settextposition(0,0);
        _settextcolor(12);
        _outtext("(1)Enter Data (2)Save Data (3)Restore Old Data (4)Import noise (5)Plot Data
(6)Quit\n");
        e = getch( );
        _clearscreen( _GCLEARSCREEN );
        switch(e)
        {
            case'1':
                printf( "\nDATA ENTRY MODE: (press any key to continue...)\n");
                getch( );
                for (z=0;z<3;z++)
```

```
            tsin[z] = create(z, tempo);
        for (z=3;z<500;z++) tsin[z]=0;
        printf("DONE! (press any key to continue...)");
    break;
    case'2':
        printf("\nSaving to disk...");
        fp=fopen("B:\\data.d", "w" );
        for (z=0; z<500; z++ )
            save( fp, tsin[z]);
        fclose (fp);
        printf("\nSave Complete. (press any key to continue...)");
        break;
    case '3':
        printf("\nRestoring sin data...");
        fp = fopen( "B:\\data.d", "r" );
        for (z = 0; z<500; z++ )
            fscanf( fp, "%d", &tsin[z] );
        fclose( fp );
        printf( "\nDONE! (press any key to continue...)");
        break;
    case '4':
        printf("\nRestoring noise data...");
        fp = fopen( "B:\\noise.d", "r" );
        for (z = 0; z<500; z++ )
            fscanf( fp, "%d", &noise[z] );
        fclose( fp );
        printf( "\nDONE! (press any key to continue...)");
        break;
    case '5':
       count=1;
        printf("Processing data");            /*Auto-Centering routine*/
        for ( x = 0; x<629 ; x++ )
        {
            tempnum=0;
            for (m=0;m<500;m++)
                tempnum =  (150.0 * sin ((x*tsin[m])/ divisor)) + ( sin ((x*noise[m]) / divisor )) +
tempnum;

            doubley = ((multiplier * tempnum)+169);
            same[x]=(int) doubley;
            totalsig[x]=same[x];
            totalsig2[x]=same[x];
            totalsig3[x]=same[x];
        if (x%100==49 || x%100==99)
            printf(".");
            if (same[x]<30 || same[x]>330)
            {
                multiplier=(multiplier/1.1);
                x=x-1;
                if(x<0)  x=0;
                continue;
            }
        }
            _clearscreen ( _GCLEARSCREEN );
        _setcolor(4);
        for ( x = 1; x<629; x++ )
            _setpixel(x, 169);
```

```
while (count==1)                                  /* Plotting Menu*/
{
    _setcolor(15);
    _rectangle( _GBORDER, 0, 0, 629, 340 );
    _settextcolor(7);
    _settextposition(1,1);
        _outtext("(1)Plot      (2)Plot      (3)Plot            (4)Clear Screen (5)Main
Menu");
    _settextposition(2,1);

    sprintf(buffer, "(6)Plot        Filter%d (7)Plot             Filter%d (8)Plot       Filter%d",
af, spnf, slpf);

    _outtext(buffer);

-
    _settextcolor(9);
    _settextposition(1,9);
    _outtext("Sines");
    _settextcolor(13);
    _settextposition(1,23);
    _outtext("Noise");
    _settextcolor(11);
    _settextposition(1,37);
    _outtext("Sum of the Two");
    _settextcolor(14);
    _settextposition(2,9);
    _outtext("Averages");
    _settextcolor(2);
    _settextposition(2, 34);
    _outtext("Dave's Special");
      _settextcolor(12);
     _settextposition(2,65);
     _outtext("Slope");
     e = getch( );
      _moveto(0,169);
     if (e=='1')                                 /* Plotting of sum of sine wave*/
     {
     _setcolor(9);
         for ( x = 0; x<629; x++ )
         {oldtotal=0;
             for (m=0; m<500; m++ )
             {
                 temptotal = (150.0 * sin ((x*tsin[m]) / divisor ));
                 total = temptotal + oldtotal;
                 oldtotal = total;
             }
              doubley = (( multiplier * total) +169);
             y = ((int) doubley);
              _lineto(x,y);
         }
    }

    if (e=='2')
    {                                            /* Plotting of noise wave*/
        _setcolor(13);
```

```
        for ( x = 0; x<629; x++ )
        {oldtotal=0;
            for (m=0; m<500; m++ )
            {
                total = ( sin ((x*noise[m]) / divisor ));
                total = total + oldtotal;
                oldtotal = total;
            }
            doubley = ((multiplier * total) +169);
            y = ((int) doubley);
            _lineto( x , y );
        }
    }

    if (e=='3')
    {                                   /* Plotting of combined signal */
        _setcolor(11);
        for ( x = 0; x<629 ; x++ )
        _lineto(x, same[x] );
    }

    if (e=='4')                                 /* Clearscreen*/
    {
        _clearscreen( _GCLEARSCREEN );
        _setcolor(4);
        for ( x = 1; x<629; x++ )
            _setpixel(x, 169);
    }

    if (e=='5')
        {e=-107;count=0;}

    if (e=='6')                         /* Erasing previous filter pass*/
        {
        _setcolor(0);
        for(x=1;x<628;x++)
        _lineto(x, totalsig2[x]);
        _moveto(0,169);
        af=af+1;

        _setcolor(14);                  /* Run average filtering routine */
        for(x=1;x<628;x++)
        {
            totalsig2[x]=(int) ((totalsig2[x+1]+totalsig2[x-1])/2.0);
            _lineto(x, totalsig2[x]);
        }
        }

    if (e=='7')
    {
        _setcolor(0);
        for(x=1;x<628;x++)
        _lineto(x, totalsig[x]);
        _moveto(0,169);

    spnf=spnf+1;
```

A STUDY OF THE NITROBENZENE REDUCTASE AND ITS REACTION WITH VARYING SUBSTRATES

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A STUDY OF THE NITROBENZENE REDUCTASE AND ITS REACTION WITH VARYING SUBSTRATES

Brian C. Harmon
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Abstract

Pseudomonas pseudoalcaligenes JS45 is a strain of bacteria that can grow on nitrobenzene as the sole source of carbon, nitrogen, and energy. This bacteria produces several enzymes that catalyze the biodegredation of nitrobenzene. The first enzyme studied was the nitrobenzene reductase enzyme which catalyzes the reduction of nitrobenzene to nitrosobenzene and to hydroxylaminobenzene. Our goal was to analyze the substrate range of this particular enzyme. Substrate groups that were studied are dinitrotoluenes, nitrophenols, and trinitrotoluene. 4-nitrophenol was the only substrate studied that was not reduced by this enzyme. This enzyme is somewhat unusual because it catalyzes the reduction of many nitroaromatic compounds. The second enzyme that was studied was the mutase enzyme. We used this enzyme in a semi-purified form. This catalyzes the transformation of hydroxylaminobenzene to 2-aminophenol. Our goal in this study was to find a method that was both accurate and repeatable in order to detect this transformation. Chemical and spectrophotometric ways were tested in trying to find a way to measure the mutase activity. One method was by adding 2,6-Dichloroquinone-4-cloromide (Gibbs reagent) to the reaction. A spectrophotometric method (A_{282}) was tried and is a method that will be used as a rapid means of detecting the enzyme in cell extracts.

A STUDY OF THE NITROBENZENE REDUCTASE
AND MUTASE ENZYMES

Brian C. Harmon

Introduction

Nitro compounds are widely used in solvents and pesticides. One way to degrade nitro compounds is by an initial reduction of the NO_2 group. Enzymes that catalyze this reduction are called nitroreductases. In recent years, nitroreductase enzymes isolated from animal tissues and gut bacteria have been studied in an attempt to understand their role in the activation of nitro compounds to mutagenic and carcinogenic products. Few enzymes involved in biodegredation of nitroaromatics have been isolated and purified. The nitrobenzene reductase is one that has been isolated and purified. JS45 (the nitrobenzene reductase) degrades nitrobenzene by a reductive route and . The object of this study was to study the substrate range of different compounds in a reaction with this enzyme.

Degredation of nitrobenzene by JS45 involves a novel enzymatic reaction which is catalyzed by a mutase enzyme called hydroxylaminobenzene mutase. This enzyme catalyzes the reduction from hydroxylaminobenzene to 2-aminophenol instead of reducing it to aniline (figure 1). The study of this enzyme requires a screen for enzymatic activity. In this study, both chemical and spectrophotometric assays for the mutase enzymes were attempted.

Method

Nitrobenzene reductase assay. The compounds that were to be studied, were made up in 10mM stock solutions usually in ethanol. These solutions along with NADPH were made fresh daily. The activity of this reductase was measured in KP buffer, pH 8 and varying concentrations of substrates and NADPH. The reaction was monitored at 340 nm which is the NADPH oxidation and the decrease in absorbance was recorded. KP buffer, subtrate, and NADPH were placed in a cuvette a mixed well using a plumper. The measurement of the absorbtion level before enzyme was added was noted. Then the enzyme was added to the reaction and the initial decline of absorbance was recorded and then stoichiometry was figured. All the information gathered from these experiments was condenced and put into a table (figure 2).

Nitrobenzene mutase assay. Fresh 10mM stock solutions were made daily hydroxylaminobenzene and 2-am activity of the mutase enzyme was measured in a cuvette with varying concentrations of 20mMinophenol. A .5M solution of borate buffer was also made fresh.

-Gibbs reagent. The KPO_4 (ph 7), megapure water, and one of two chemicals (hydroxylaminobenzene or 2-aminophenol). A standard of 20 µL of Gibbs reagent and 100µL of borate buffer was also added. These reactions were repeatitively scanned at A_{280} for approximately ten minutes.

-Spectrophotometrically. The activity was measured again in a cuvette with diluted enzyme, DDT, KP buffer, and HAB. The enzyme was diluted 1:20 with 5µL of DDT added to the solution. The enzyme, KP buffer, and HAB concentrations varied. A standard of 5µL DDT was used in the reaction. The reactions were recorded two ways. The first was by a repeatative scan to observe the formation of 2-aminophenol (figure 3) . The second way was to measure the absorbtion level at A_{282} (figure 4).

Results from the reductase enzyme experiments

The results from the experiments varied with the substrates and whether or not ETOH was added to the reaction. The nitrobenzene control wavelength scan without ETOH has a similar look to the nitrobenzene scan with 5% ETOH. In the wavelength scans, ETOH has little or no effect with the outcome. The amount of ETOH also has a very minute effect on the stoichiometry. However, if one looks at the single cell kinetics run using nitrobenzene without ETOH and the nitrobenzene run with 5% ETOH, he will find a difference in the rate of the decreasing absorbance level. By observing "Figure 2" one can notice the different effects that varying substrates have on this enzyme from that of the nitrobenzene control runs.

The results from the mutase assay experiments differed primarily because of the two different methods. The reactions with Gibbs reagent added did not really give us good information that could be used. It wasn't repeatable and the overall look of the data obtained from the experiment was peculiar. However, when we tested the enzyme diluted spectrophotometrically, we found that it gave us reliable data. Not only was it repeatable, but we discovered that when you double the amount of diluted enzyme, the rate of increase in the absorbtion level doubles.

Conclusion

From these experiments, we learned alot about the substrate range of the reductase enzyme and we discovered a method to record the reduction of hydroxylaminobenzene to 2-aminophenol by the mutase enzyme. By experimenting with ETOH as a carrier in the reductase enzyme experiments, we found that it had a significant effect on the amount of µmol NADPH/min/mg of enzyme. By finding a method to observe the reduction of hydroxylaminobenzene to 2-aminophenol, we are able to learn more about the mutase enzyme.

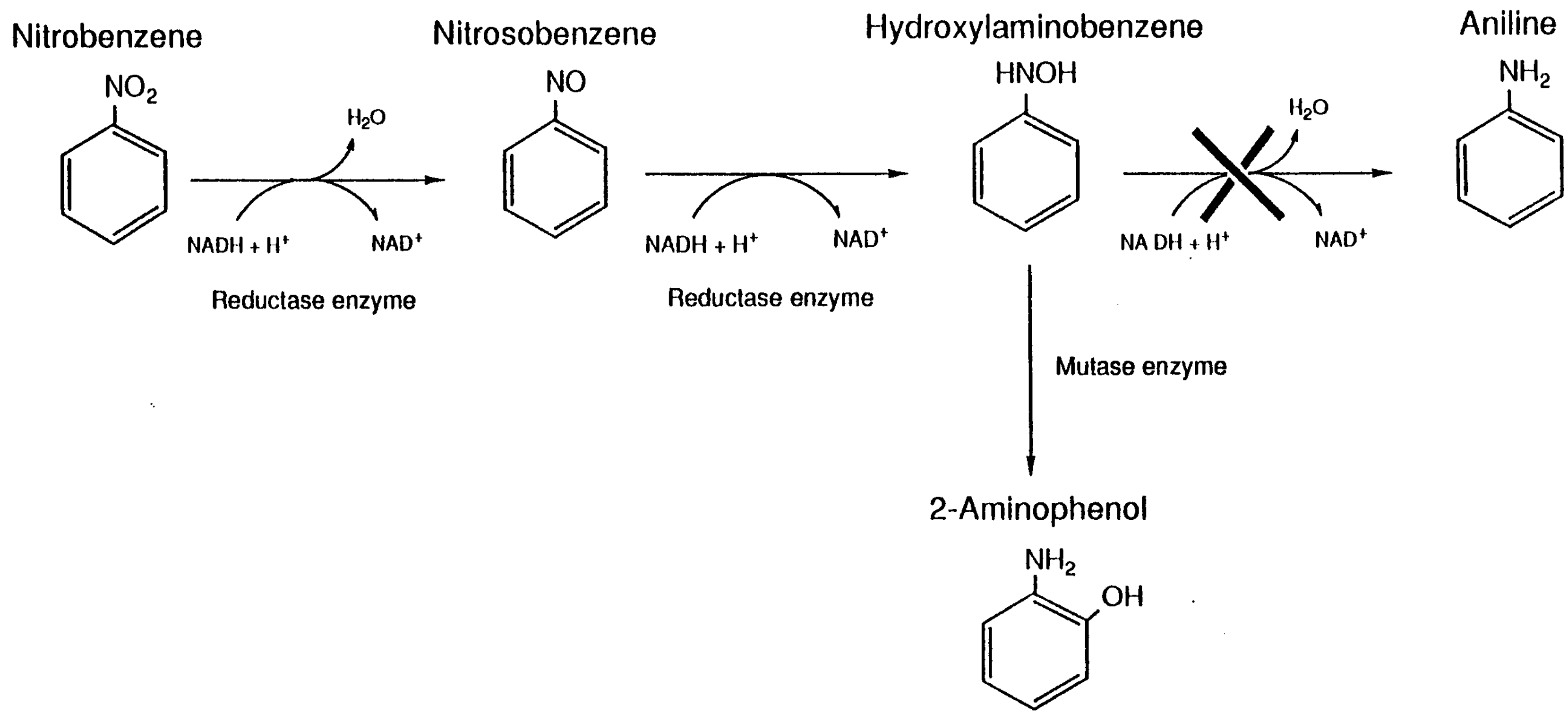


Figure 1: The path of reduction of nitrobenzene in strain JS45. Nitrobenzene is reduced through nitrosobenzene to hydroxylaminobenzene, but is not further reduced to aniline. Hydroxylaminobenzene is the substrate for a specific mutase which catalyzes the formation of 2-aminophenol.

Figure 2

Compound Name	Ave. µmol NADPH/min/mg of enzyme (0%)	Ave. Stoichiometry (0% ETOH)	Ave. µmol NADPH/min/mg of enzyme (5%)	Ave. Stoichiometry (5% ETOH)
Nitrobenzene	106.7	2.51	35.8	2.6
2,3-DNT	Not Done	Not Done	46.8	3.1
2,4-DNT	122.6	2.87	65.6	2.92
2,6-DNT	48.1	2.52	20.9	2.88
3,4-DNT	32.0	4.64	Not Done	Not Done
2-Nphenol	13.8	1.78	Not Done	Not Done
3-NPhenol	81.2	2.26	Not Done	Not Done
TNT	96.5	3.02	Not Done	Not Done

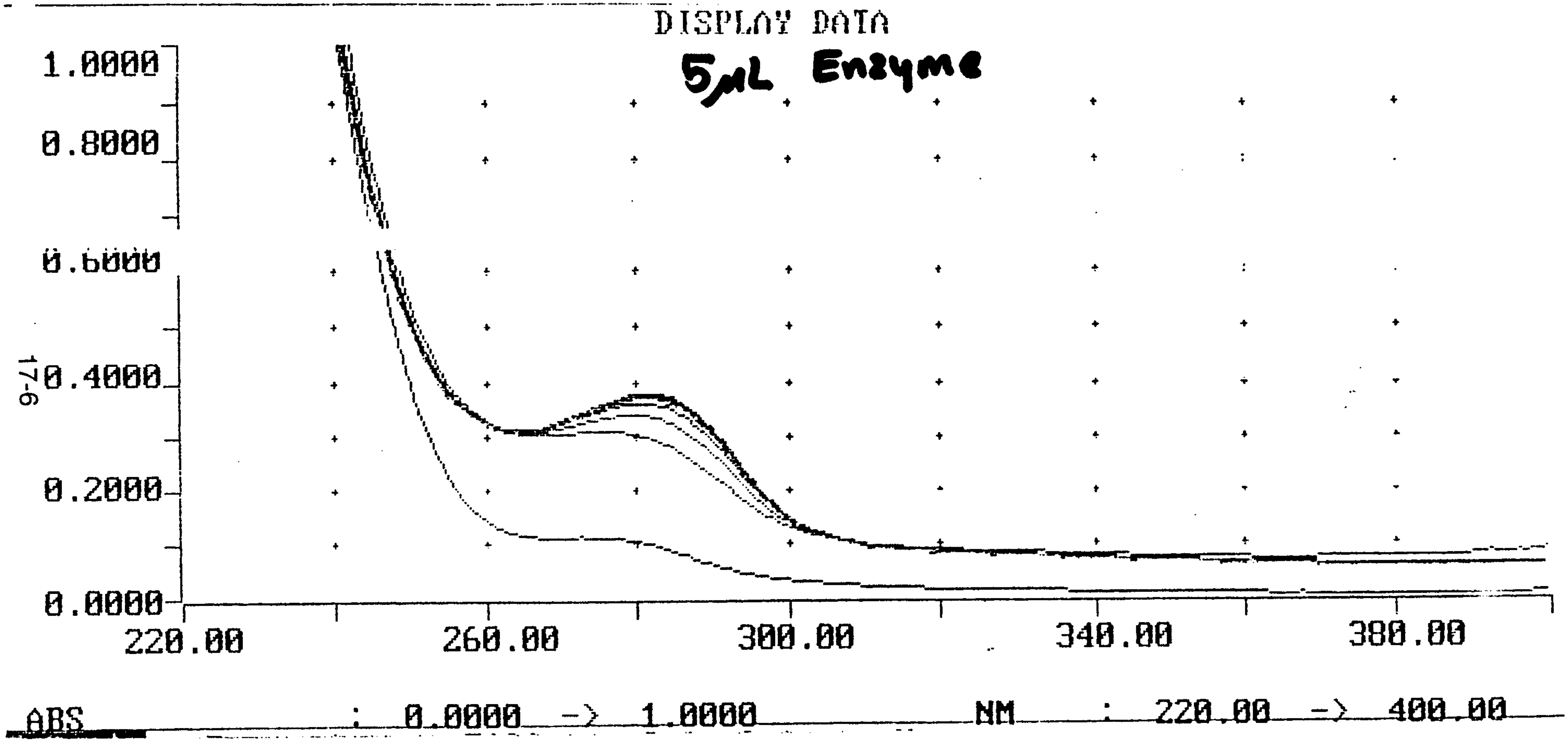


Figure 3: Repeatative scan of the mutase assay with 5µL of diluted mutase enzyme. The primary scan was HAB, KP buffer, and DDT. The other scans contained the added diluted mutase enzyme. The scans were 35.8 seconds apart.

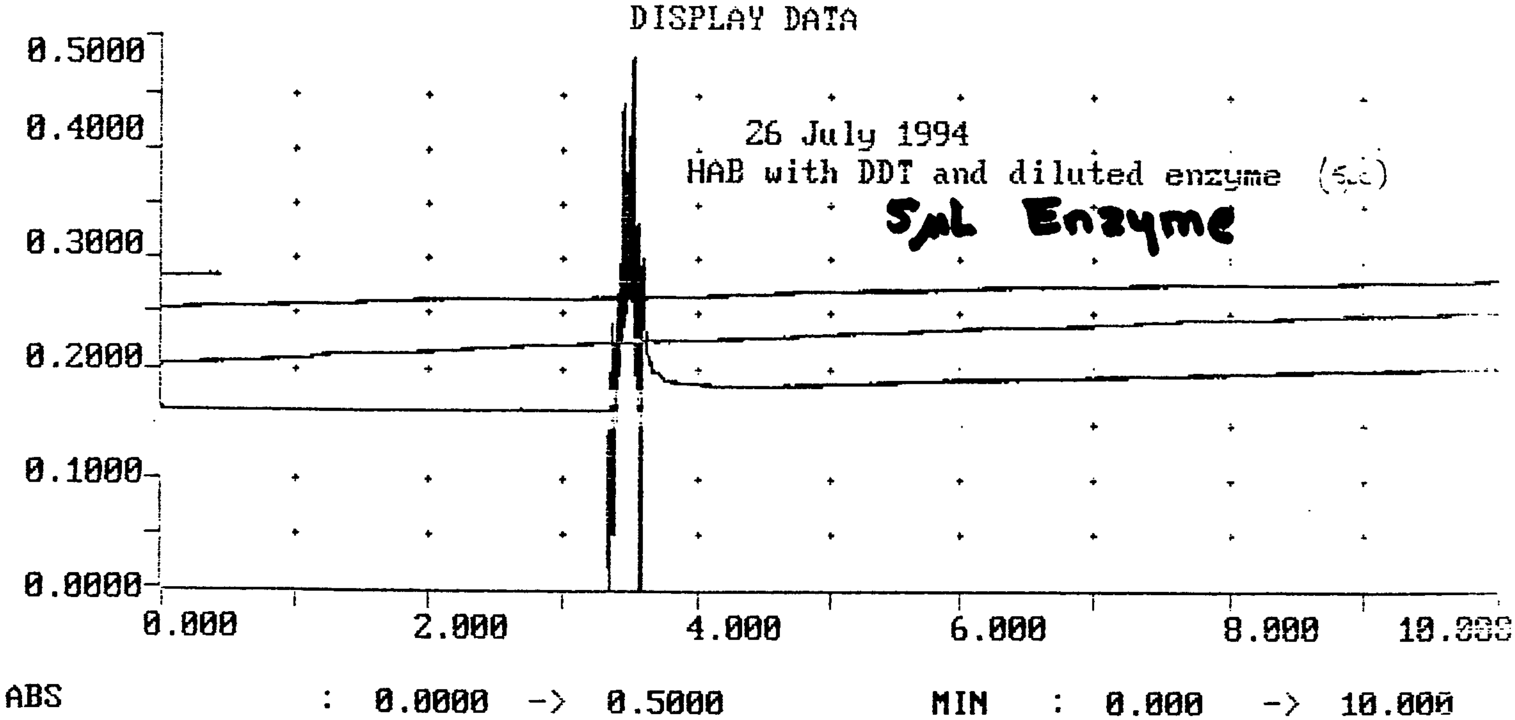
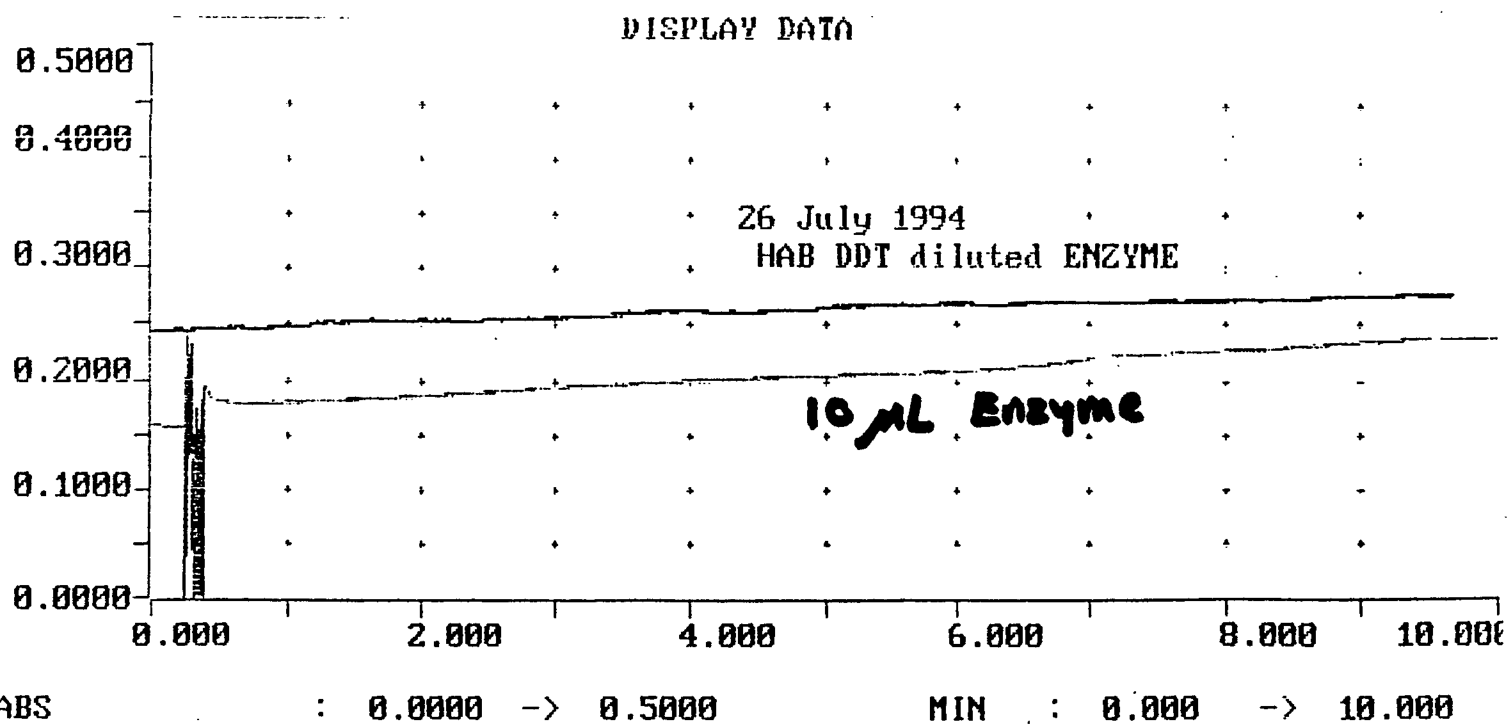


Figure 4: Wavelength scan of the mutase assay at A_{282}. The top scan contained 5μL of diluted enzyme and the bottom contained 10μL of enzyme.



THE KNOWLEDGE SURVEY AND ASSESSMENT (KSA) PROJECT

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Final Report for:
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THE KNOWLEDGE SURVEY AND ASSESSMENT (KSA) PROJECT

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Abstract

The objective of this apprenticeship was to assist in the development of the Knowledge Survey and Assessment (KSA) project, also referred to as the "20-Questioner". The goal of the KSA Project is to measure the depth and breadth of technical knowledge possessed by airmen in a wide variety of technical areas. The first step of the KSA project is to transfer questions from paper-and-pencil booklets onto a computer and to develop an automated system of administering the tests and assessing their results. Then, over the next several years, data will be collected from knowledge surveys that will be given to thousands of airmen in conjunction with the project. Eventually, a large enough database will have been assembled to be able to employ an intelligent interrogation strategy to assess an airman's knowledge by a series of carefully selected questions. Development of the first stage of the project, item generation, was begun during the term of this apprenticeship.

THE KNOWLEDGE SURVEY AND ASSESSMENT (KSA) PROJECT

Wesley R. Hunt

Introduction

In assessing one's knowledge, the efficiency in which accurate results can be obtained is vital. Redundant or repetitive questions would be a waste of time and resources, when a series of intelligently selected questions could give results as accurate or better. Because the Knowledge Survey and Assessment Project is concerned with one's *general* knowledge, it would not be feasible to subject an airman to a complete battery of tests from all the technical areas of interest. What is needed is a system that can decide, based on the subject's responses and a database containing the correlations of item difficulty and their relation to other questions, what would be the next appropriate question to ask the examinee. The sophisticated *knowledge interrogation strategy* that will be employed to accomplish this can be likened to the strategy used by an expert player of the game "20 Questions."

Suppose there are 100,000 facts relevant to the domain of the test. The 20-Questioner system can assume that a person's knowledge is roughly equal to that of the general population (or the average airman). Even after the first question, the system can begin fine-tuning the default assumptions as given by the database. So based on the correlations and question dependencies, the 20-Questioner can make a guess as to whether the examinee will know the answer to questions not asked yet. For example, if an examinee does not know basic mathematics, the 20-Questioner could safely conclude that the subject probably will not know questions dealing with calculus, probably will not know questions having to do with physics, and it would be plausible to assume a lack of knowledge in US. History. Note that the latter assumptions do not as closely correlate to the initial question as did the former, but they can generally be concluded correctly. The purpose of the 20-Questioner is to quantify this kind of plausibility.

The potential uses for the 20-Questioner are any case in which a person's knowledge needs to be evaluated. Two primary applications would be in aptitude testing and adaptive training. Adaptive training presents a particular need for general knowledge assessment to be able to optimize instruction. For example, water analogies are not likely to be of much use in explaining how electricity works to an examinee who knows little about hydraulics.

Methodology

The main concern in the primary stages of the 20-Questioner was to create an automated system of reading and displaying the general knowledge test questions. This will eventually become the method the 20-Questioner uses to display the question data. The Apprentice Knowledge Tests (AKT) were used to collect a sufficient amount of questions covering a broad base of technical knowledge. The AKT was previously used by airmen to bypass their requirements for technical training. Recent changes in training system regulations have made "testing out" of technical areas no longer an option. Thus, the questions are not currently in use, but the possibility exists of reactivation in the future, so the confidentiality of the questions had to be maintained during the collection process.

The materials were acquired in a hard copy format from the actual test booklets. The booklets were scanned into a computer where an Optical Character Recognition (OCR) program converted the bitmapped scan into processable text. The text files were then proofread for scanning errors, which could be fairly numerous due to the numerous illustrations and somewhat inconsistent format of the tests.

The next step was to develop a strict format to put the questions into so that the test administration program could read and display the question data. Microsoft Visual Basic was used to develop this program. It was important that the appearance of the question be preserved as much as possible, so the administration program had to take into account a variety of situations that arose during the transcription of the question such as: order and position of the illustrations with respect to the question, the occasional question that presented pictures as choices, and the size of the illustration relative to the screen. Some illustrations were too large to fit in their respective question or choice box, so various techniques were employed to make the presentation of the question as convenient to the examinee as possible. Because the testing system was operating under the Microsoft Windows environment, as a last resort a separate window could be brought up overlaying the question to display the particularly large pictures. The examinee could then press appropriately titled buttons with the mouse to display and hide the picture, flipping easily between the illustration and the question. The location of the window could also be altered by dragging it around the screen to potentially look at the question and the illustration simultaneously. The interpreter was also equipped with an encryption/decryption algorithm to protect the test pools from unauthorized access. There were ninety-four Apprentice Knowledge Tests in all, each consisting of one hundred questions and a varying amount of illustrations.

Results

Development of the preliminary testing system was completed and fine-tuned during the eight week period of the apprenticeship. Also, approximately seventy-five of the test booklets were converted into the testing system format, and over three hundred and fifty illustrations were drawn and made to fit the screen limitations. After all the pools are converted and the installation procedures are finalized, testing can begin and data can start being collected for the "intelligent interrogator" stage of the 20-Questioner. The target date for the completion of the project is four years into the future, allowing for the collection of sufficient data, the building of the probability database, and the creation of the intelligent interrogation system.

Conclusions

The purpose of this summer research apprenticeship was to help in the development of the primary stages of the "20-Questioner" project. Progress was consistent, although a few problems emerged while transcribing the test pools that will have to be dealt with at a later time.

1. Some of the pools contained illustrations on fold-out pages that were too large to fit on the screen. In some cases the picture size could be reduced to make it fit, but in others the picture was too large to shrink down

and still preserve its readability. As a result, those questions may have to be left out of the pools.

2. In addition, Apprentice Knowledge Test makers had, for various reasons decided that certain questions were unusable. But the tests were taken out of active use before the tests could be updated. A decision will have to be made as to which of those items are usable and which will have to be left out of the pool.

3. Also, some of the material from the Apprentice Knowledge Tests crossed over to several different specialty areas, resulting in redundant questions throughout the pools. When the transcription process is complete, this issue will have to be dealt with. A possible solution is to mark the question item in the file as a duplicate, list its cross-references, and then have the administration program skip over the item if it has already asked that question during the current session. Also, contingent upon how the intelligent interrogation database is formed, it may also be feasible to make a cross-reference to duplicate items one of the question dependencies listed in the database.

HYPERBARIC MEDICINE

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Abstract

Hyperbaric Oxygenation is a medical treatment where the patient breathes 100% oxygen while in a chamber filled with compressed air. This treatment can be used for many different medical problems, along with surgery, antibiotics, or other therapy.

HYPERBARIC MEDICINE

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Introduction

Hyperbaric Oxygen (HBO) is a fairly new concept. In the late thirties, oxygen at pressure was proposed as a treatment for decompression sickness, then fairly common in divers. It was not until the early sixties that Dutch investigators showed that hyperbaric oxygenation could be used to treat gas gangrene and anemic states. Later in that decade, hyperbaric oxygen therapy became a standard treatment for naval diving accidents. Subsequent studies have shown the benefits of hyperbarics in the treatment of wounds, the enhancement of white cell killing ability, the preservation of hypoxic tissue, and angiogenesis. Clinical indications for the use of hyperbaric oxygen therapy continue to be defined.

Methodology

Normal air is approximately 21% oxygen at 14.7 psi. In a hyperbaric chamber the pressure can be up to three times normal, and pure oxygen is breathed. This increases the amount of oxygen in the blood to many times normal level, delivering more oxygen to all parts of the body. The arterial partial pressure of oxygen during a dive will actually approach a pressure equal to that of 45 feet of sea water. This increase in the blood oxygen level can help improve healing and control infection in some instances.

There are two types of hyperbaric chambers. There is a multiplace chamber, a large walk-in cylinder. Compressed air is pumped in and oxygen is breathed through hoods, masks, or endotracheal tubes. A monoplace chamber can also be used, in which no hood is necessary. The reason for this is the small size of the chamber, which permits the entire chamber to be pumped full of 100% oxygen. The pressure is approximately 2.4 times that at sea level, which is why the treatments are called "dives". When a dive is over, the pressure is gradually released, bringing the chamber back to sea level. The large chamber is equipped with seats, oxygen equipment such as hoods, masks, or endotracheal tubes, glass ports (windows), an intercom system to speak with individuals outside the chamber, and a medical lock compartment to transport materials between the chamber and outside. The monoplace chamber is like a bed covered with glass, equipped with an intercom system, but no lock compartment.

The staff at any hyperbaric facility includes nurses, physicians, physiologists, and medical and chamber technicians. All have had formal courses for specialized training in hyperbarics.

Safety

Because of the increased oxygen percentages, there is a greater risk of fire. Therefore, no cigarettes, matches, lighters, etc. are allowed in the chamber. Alcohol or petroleum based products could also cause problems. Special clothing and shoes are required for any person diving in the chamber. Watches, dentures, and contact lenses must also be removed.

Effects

Although hyperbaric oxygenation is generally painless, there are some common side-effects. At the start and finish of each dive, a patient can feel some fullness in his ears (such as when travelling in an airplane), and the eardrums may produce a popping or crackling noise. Some may experience difficulty clearing ears, have sinus pain, or develop nausea. A valsalva maneuver or nasal spray can help ears, and a patient can always be removed from the chamber in an emergency. The chamber can also get slightly warm at descent, and cool on ascent.

Benefits

There are many benefits of hyperbaric oxygenation. Blood flow to injured tissue, blood vessel formation, and new bone formation are all increased. Swelling is reduced, as is risk of infection and effects of toxic substances. Enhanced wound healing is yet another benefit.

Reasons For Use

Hyperbaric oxygenation is helpful in many emergency situations. Decompression sickness, also known as the bends, is common in divers. Arterial gas embolism and severe carbon monoxide poisoning are also indications for use of hyperbarics. Other conditions such as gas gangrene, osteomyelitis, radiation tissue damage, anaerobic infections, crush injuries, and compartment syndrome are additional reasons for hyperbaric oxygen treatment. In some problem wounds, including diabetic ulcers, arterial insufficiency ulcers, and mixed soft tissue infections, enhancement of healing is common during and following hyperbaric therapy. Hyperbarics is also used in necrotizing soft tissue infections of subcutaneous tissue, muscle, or fascia, particularly in the compromised host. Chronic refractory osteomyelitis and radiation necrosis of either bone or soft tissue can be treated with hyperbaric oxygen, as can compromised skin grafts or flaps, thermal burns, and excessive blood loss anemia.

Problems

There are several factors that can affect the outcome of hyperbaric treatment. Smoking decreases the amount of oxygen the blood can carry, and is therefore not recommended. One should not consume alcohol for eight hours prior to a dive. Lastly, all illnesses such as colds and diarrhea should be reported; all medications need to be approved by a physician.

Conclusion

Hyperbaric medicine is an exciting therapy, treating many conditions that were previously difficult or impossible to treat with other methods. There are aspects of hyperbaric oxygen therapy that are not yet realized, and research is continuously being conducted in an attempt to utilize this valuable treatment to the fullest extent possible.